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W. THELWALL THOMAS, F.R.C.S., President.

DISCUSSION ON THE DIAGNOSIS AND TREATMENT OF PRIMARY CARCINOMA OF THE STOMACH.

OPENING PAPER.

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IT is a matter to me of some interest to recall the fact that some thirty odd years ago, when Billroth's first stomach operations were performed, the late Sir John Erichsen in speaking to me expressed his regret that the operations should have been performed and published, as he considered their publication would entail a great deal of useless suffering on patients who were likely to be operated upon by surgeons attracted by Billroth's proposition. At the present day a great advance has been made on that position, yet it is still an undoubted fact that far fewer subjects of gastric carcinoma come into the hands of the surgeon than should be the case; again, that they do so less frequently than do patients with carcinoma of the remaining portion of the alimentary tract, although operative treatment of the disease has been ably advocated in this country by Robson, Moynihan, Paterson, and others.

The disease occurs with great frequency, since it is computed that carcinoma of the stomach accounts for 21 per cent. of all cancers, the incidence thus following closely on carcinoma of the uterus.

The fact that surgical means are not more generally resorted to in the treatment of carcinoma of the stomach depends on two circumstances: (1) The difficulty of early diagnosis of the disease; (2) the want of general appreciation of the results which can be attained.

Incidence of Carcinoma in Various Parts of the Intestinal Tract.

Year.	Stomach.	Small Intestine.	Large Intestine.	Rectum.	Total.
1901 ...	29	4	21	22	76
1902 ...	23	1	19	27	73
1903 ...	31	0	24	32	87
1904 ...	30	1	25	32	88
1905 ...	38	0	15	35	88
1906 ...	40	0	25	32	97
1907 ...	45	0	47	17	109
1908 ...	53	1	38	29	121
1909 ...	44	1	21	30	96
1910 ...	49	1	24	43	117
1911 ...	32	1	28	43	104
1912 ...	41	0	40	35	116
	458	10	327	377	1,172
	39 %	0.8 %	27.9 %	32 %	

Total number of patients for the years 1903-12, 70,234, with 403 cases of malignant disease of the stomach. Incidence, 0.57 per cent.

The above table shows:

1. The incidence of carcinoma of the stomach in patients undergoing treatment in a general hospital. Thus, of 70,234 cases treated in the medical and surgical wards of St. Thomas's Hospital, 403 were the subjects of gastric carcinoma (0.57 per cent.).

2. The incidence of carcinoma in the various portions of the alimentary tract from the stomach downwards.

It may be noted that the table shows a slight continuous increase in the number of patients coming under treatment, which probably corresponds with the slowly growing appreciation of the fact that such patients may be successfully dealt with by surgical methods. It is of some interest to compare the numbers in this table with a similar compilation made by Dr. Mayo at St. Mary's Hospital, Rochester, in which an exact reversal of the proportionate occurrence of cases of carcinoma of the stomach and carcinoma of the large intestine respectively is seen.

	St. Thomas's (12 years).		St. Mary's, Rochester (14 years).	
	Number.	Per Cent.	Number.	Per Cent.
Stomach	458	39.0	863	68.2
Small intestine	10	0.8	14	1.1
Large intestine	327	27.9	219	17.3
Rectum	377	32.0	168	13.2
Rectum and large intestine together	704	60.0	387	30.6
Total	1,172		1,264	

Operable Cases.—St. Thomas's, 31.4 per cent.; St. Mary's, Rochester, 35.5 per cent.

I believe this to depend on the fact that where operations on carcinoma of the stomach are freely performed their success is demonstrated and the supply of cases increased. Conversely, the surgical treatment of carcinoma of the bowel has acquired an earlier recognition than that of the same disease of the stomach. This is no doubt in part due to the fact that growths of the colon and rectum are more easy of diagnosis, but chiefly because the medical attendant has always been ready to resort to surgery for the relief of intestinal obstruction, which for a long period he has known could be relieved by a simple colostomy, and for a shorter period he has become familiar with the results of partial colectomy. Thus, of the 704 cases in the table, 45 per cent. were admitted for intestinal obstruction. On the other hand, the distressing results of pyloric obstruction are not to be relieved by the simple expedient of establishing a fistula, a step which for many years has acquired a definite position in the treatment of the less hopeful conditions of carcinoma of the gullet. The introduction of gastro-enterostomy made the first step in carrying the conviction that surgery could aid, and from that the possibilities of gastrectomy are only slowly gaining the notice they deserve.

THE DIAGNOSIS OF GASTRIC CARCINOMA.

The early diagnosis of carcinomata of the intestinal tract is difficult throughout, and that of carcinoma of the stomach is perhaps the most difficult of all. Yet in early diagnosis lies the whole crux of dealing with this disease on an adequate scale.

The mere persistence of symptoms of indigestion, which differ little or not at all from those accompanying simple conditions of the stomach, except, perhaps, in their intractability may be all that exists to arouse suspicion. Such symptoms occurring in any patient of middle age, especially in a man, should lead to special investigation, particularly if they commence suddenly with a previously good digestive history, or if they supervene after a long interval of health following earlier signs of a gastric ulcer.

METHODS OF INVESTIGATION.

A determination of the functional capacity of the stomach by a test meal. From this we learn that the passage of the contents of the stomach is delayed either as a result of deficient motor power, or of mechanical obstruction, either by noting the delay in digestion of certain food elements, or by the presence of an undue amount of the ingested food after an interval which should

have sufficed to allow the organ to have completely emptied itself.

Chemical tests may show us that the gastric juice is defective in some of its elements with consequent loss in digestive power. In carcinoma deficiency in the ferments is of the lesser importance since it is generally allowed that no feature pathognomonic of the disease has been actually established.

The observation of Golding-Bird, in 1842, that the free hydrochloric acid normally present in the gastric juice gradually diminishes in amount in cases of carcinoma of the stomach as the disease progresses, while the organic acids steadily increase in quantity, has of late years been further investigated by many workers. Although increased experience has fully supported Golding-Bird's observation, yet the absence of free hydrochloric acid has been found to occur in other diseases (such as chronic gastritis, alcoholic gastritis, severe anaemia, chronic pulmonary tuberculosis, and some nervous diseases), while in carcinoma it is uncertain in degree. It has been shown that in some stages of carcinoma of the pylorus hyperchlorhydria, or at least euchlorhydria, is met with, just as is found in pyloric or duodenal ulcer or simple pyloric obstruction, although in carcinoma of other portions of the stomach absence of free hydrochloric acid is the rule. This observation has led Schryver[1] and Singer to consider it probable that changes in the composition of the gastric juice depend rather on the site than on the nature of the lesion. They further conclude "that carcinoma of the stomach has no specific effect on the composition of the gastric juice, although both pepsin and chloride readings are generally lower than in other conditions."

Panton and Tidy[2] dwell upon the importance of the length of history of the individual case in forming any conclusion as to the cause of the absence of free hydrochloric acid, suggesting that in a case with two years' gastric symptoms the absence of free acid points to carcinoma, while absence of acid in a patient with four years' gastric symptoms is not likely to indicate the presence of carcinoma. The presence of abnormal organic acids, such as lactic and butyric acids, is of less constancy and importance from a diagnostic point of view, and the same remark applies to the presence of certain organisms, such as the Oppeler-Boas bacillus and the *Bacillus filiformis*, which are not uncommonly present in cases of carcinoma of the stomach.

Microscopical examination may offer further aid by revealing the constant presence of blood in small quantities, fragments of the growth, or evidence of imperfect digestion of the elements forming the test meal. The microscopic determination of the constant presence of blood in the faeces has also been regarded as an evidence of carcinoma.

It is a somewhat striking commentary on the efficiency of these methods that in the clinic of Drs. W. J. and C. Mayo,[3] where every means exist for their use, the simple plan of determining gastric insufficiency by testing the power of the stomach to rid itself of some incompletely cooked rice and raisins in eight or ten hours is used in order to decide on the advisability of an exploration.

Skiagraphy is now generally employed as an aid to diagnosis, and is capable of furnishing valuable evidence as to motor sufficiency, and the capacity of emptying itself possessed by the stomach. Beyond this, in the later stages, interference with the normal outline of the organ and deficiency in peristalsis in the affected part of the organ may point to the presence of a tumour. The beautiful series of serial radiographs produced by Professor Lewis Gregory Cole[4] of New York shows what valuable information as to the extent, position, and nature of the growth may be obtained by this method in the fully developed stages of the disease, but at present this method is too expensive to come into general use, and its value in the early stages is not yet demonstrated. Dr. Cole says even in the early cases some of his findings are sufficiently definite to justify him in stating with a reasonable degree of certainty that the process is malignant. The value of skiagraphy in readily determining the location of a tumour in the stomach or transverse colon respectively is obvious, while the method has also proved useful in determining the site and presence of a gastrocolic fistula as well as demonstrating the nature of the disease (Handek).

A number of other aids to diagnosis—such as examination of the blood, serum diagnosis, determination of the power of the stomach to assimilate certain drugs and pass them on to the urine, and the direct examination of the interior of the stomach by the gastroscope—cannot be regarded in their degree of development as of great practical diagnostic value.

In the present state of our knowledge it is, unfortunately, clear that no symptom or complex of symptoms allows of a certain diagnosis of the early stages of gastric carcinoma, and we are driven to the ruder procedure of making an exploratory incision. Even this may fail. Thus Mr. Paterson records a case in which a small carcinoma at the junction of the oesophagus and cardiac extremity of the stomach was not discovered; but it may be fairly said that at this stage of the disease, whether the condition be carcinomatous or not, no grave risk is involved in the procedure.

The diagnosis of advanced carcinoma offers less difficulty; here symptoms such as pain, vomiting, haematemesis, melaena, dilatation of the stomach, obvious peristalsis, the presence of a palpable tumour, may make the detection of the disease easy enough. The presence of a tumour is the most useful of these signs to the surgeon. It gives valuable information as to the locality of the disease, whether at the pylorus or the body of the stomach, its size, consistence, and degree of fixity. In employing this information it must be borne in mind that the tumour may have assumed an abnormal position, thus low in the abdomen, or it may be pushed over to the right by a dilated stomach or drawn up to the left by contraction of the organ. It may be difficult at once to distinguish from a tumour of the colon or pancreas. Lastly, it may be only occasionally palpable, then generally with light pressure only, and occasionally it may vary in size. With regard to the last point, it is well to bear in mind that variability in size of the tumour may be due to muscular spasm, and that this, if accompanied by pain, is far more suggestive of an inflammatory lesion than of carcinoma.

Here, again, the question of an exploratory operation may arise not for diagnostic purposes, but to determine whether the case comes within the limits of operability, and what operation is advisable. It should be said at once that an exploration in this stage of the disease should be less lightly undertaken than in the earlier stages. Experience has abundantly proved that such explorations are not devoid of danger, and should not be embarked upon without full consideration of the condition and the power of the patient to bear the operation.

Even with the advantage of direct examination the difficulties of diagnosis are not ended. The differentiation of different types of growth—for example, sarcoma, myoma, or endothelioma—may not be an exacting task, since each has some characters of its own, and each is suitable for radical treatment if operable. The differentiation of inflammatory conditions and carcinoma is less easy, and in some cases insuperable. A long clinical history, the localized nature of the constriction, and the presence of adhesions of the band form, are valuable aids in relegating a constriction of the pylorus to the inflammatory class, but in a considerable proportion of cases a doubt must exist until the matter is settled by the histologist. In such the performance of a partial gastrectomy is justified by the safety with which the operation may be performed, and the satisfactory result which may be obtained. The frequency with which these errors may be made has been well shown by Professor Alexis Thomson, who found among 24 cases of probable carcinoma 6 to be chronic fibrosis following ulceration; of 25 collected cases, 7 to be non-malignant; and of 21 museum specimens, 6 to be non-malignant, which causes him to suggest that all cases of "atrophic carcinoma" are really of a non-malignant fibrous nature.[5]

METHODS OF TREATMENT.

These depend upon the position and extent of the growth. With regard to position, carcinoma of the cardiac end of the stomach is generally unsuitable for operation, except in the form of a palliative gastrostomy.

Growths of the body of the stomach may be treated by gastrectomy, anastomosis, or, rarely, by jejunostomy. The

last operation has been advocated by Mr. Mayo Robson and Dr. W. J. Mayo, who say, in cases of cardiac obstruction and in diseases affecting a considerable portion of the wall of the stomach rendering gastrostomy impossible or difficult, jejunostomy is as efficient and easier of performance than gastrostomy.

Pyloric growths which form from 50 to 60 per cent. of the series are the most generally satisfactory cases for operation, whether by anastomosis or excision.

The limits within which radical operations may be undertaken are fairly wide. They are determined by the extent of the primary growth. Extension along the lesser curvature is the most serious direction in the localized and pyloric cases, since if the growth reaches the cardiac extremity no chance of a radical operation remains. With regard to the cases complicated by the presence of scattered nodules, it may be easier and more satisfactory to perform partial gastrectomy than to establish an anastomosis, since the removal of the nodules gives the newly-formed channel a greater possibility of escaping invasion of the growth. As to the actual extent of involvement, if a handbreadth of the cardiac end of the stomach is free it suffices to allow of a satisfactory anastomosis. Where a large extent of the central portion of the stomach is involved a total or subtotal gastrectomy may be performed, the limits of practicability being governed by the rules laid down below.

(a) The Degree of Lymphatic Invasion.

For practical purposes the classification of the glands into those of the greater curvature, the subpyloric, the retropyloric, and the lesser curvature groups is the most useful. The exhaustive study by McCarty and Blackford[6] of the glands in 200 cases of gastric carcinoma removed by operation has substantiated much that was known, and has allowed them to draw valuable conclusions.

This study shows that the regional involvement of the glands bears a definite relation to the position of the primary growth, but that the size of the primary lesion has no corresponding effect on the extent of the glandular enlargement. Again, that clinically there is no apparent relation between the duration of the symptoms and the extent of the glandular enlargement. The size of enlarged glands is no indication of carcinomatous involvement; large glands may be inflammatory, small ones carcinomatous. Again, as in the case of intestinal carcinomata, the path of invasion is not always obviously continuous, glands or groups of glands being skipped. In McCarty and Blackford's series 1,404 glands were examined microscopically, and in these carcinomatous invasion was proved in 52 per cent. It is also shown in this series of cases that both the immediate mortality and the length of interval before recurrence of the disease were directly affected by the extent of the glandular involvement.

(b) Direct Extension to Neighbouring Organs.

Involvement of the transverse colon and transverse mesocolon is perhaps the least formidable. The main point to bear in mind in dealing with the mesocolon is the middle colic artery, and, if this cannot be spared, the whole transverse colon must be sacrificed. Many cases of successful removal of growths involving both stomach and transverse colon have been recorded. Perthes[7] has recommended that both growths should be removed in one mass, and records four operations with one death. He points out as an inducement to perform this operation that the growth in such cases involves the greater curvature of the stomach, the region in which glandular involvement is most hopefully dealt with.

(c) Extension to the Duodenum.

This is comparatively rare. Langwill,[8] in a study of 200 cases in Professor Caird's clinic, found it to have occurred in 5, or 2½ per cent. It is well to bear in mind at an exploratory operation that tumours of the florid variety often project freely through the pylorus into the lumen of the duodenum without involving its wall.

(d) Pancreas.

When carcinoma of the lesser curvature, especially carcinoma engrafted on an old ulcer, extends into the body of the pancreas, the case must be regarded as unsuitable for operation. In a certain number of cases either the primary growth or the retropyloric glands may involve a part of the head of the pancreas; in this situation portions of the gland may be successfully removed, the peritoneum being sutured over them.

Extension to the Liver and Gall Bladder.

This is an undesirable complication, but portions of the liver have been successfully removed by Mayo Robson and others, while the addition of a cholecystectomy is not a serious addition to a partial gastrectomy.

CONTRAINDICATIONS TO OPERATION.

The general condition of the patient may be a bar to any form of serious operation; in some such instances a preliminary jejunostomy has been proposed. It suffices to

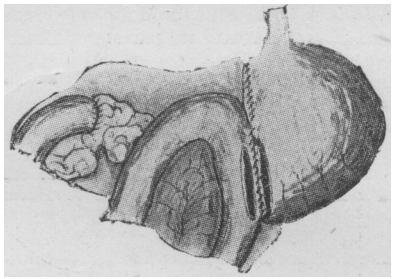

Fig. 1.—Wilms.

enumerate such contraindications as visceral metastases ascites, extension to the abdominal wall, or distant lymphatic enlargements, as in the posterior triangle or the groin. The question may be raised whether apparent extension of glandular involvement to a degree incompatible with complete eradication is to be looked upon as an actual bar to the operation of gastrectomy. In answer to this it may be replied that a doubt may always exist as to the nature of the glands left behind; and secondly, that the patient may be much better, even if some glands do remain, when the primary growth is of the florid variety or is ulcerating, than with the alternative gastro-enterostomy.

Gastro-enterostomy is almost as severe an operation as partial gastrectomy, and the duration of the relief it affords does not exceed an average of five months. It must be allowed in stating this general average that the cases

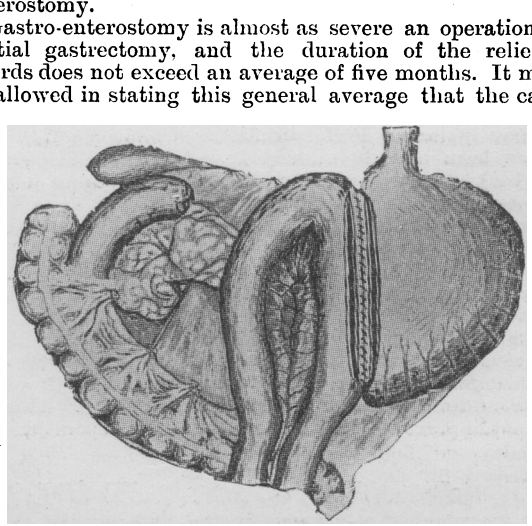

Fig. 2.—Polya, Reichel.

dealt with include the most unpromising for any form of treatment; but gastro-enterostomy, as the less satisfactory procedure, should be resorted to only in cases in which the state of the patient or the extent of the growth renders the more radical procedure impracticable. The objection to gastro-enterostomy, even as a preliminary procedure, is a real one. The technical conditions may be influenced for the worse when the second operation is undertaken, while, the patient often withholds consent to the second operation too long, as a result of the temporary relief following the establishment of the anastomosis.

The best method of partial gastrectomy is an operation on the lines of Billroth No. II, either a posterior or anterior gastro-enterostomy being performed, as may prove the more convenient in the individual case.

When the remnant of the cardiac end of the stomach is too small to allow of a convenient lateral anastomosis, the loop of jejunum may be applied directly to the opening of the divided stomach by one of the methods devised by Polya, Reichel, Wilms, etc.[9] (Figs. 1 and 2).

One other technical point should be raised. In early days especially, leakage from the duodenal stump was a troublesome and often fatal sequela to the operation. This even led some surgeons to advise that the severed end of the duodenum should be fixed in the abdominal wound. The difficulty should only occur if the duodenum has needed to be cut very short; in this case it may be sewn down to the peritoneum over the pancreas. Lewitt[10] has suggested that an end-to-side anastomosis of the duodenum into the distal limb of the loop of jejunum attached to the opening in the stomach should be made, and has employed the method with success (Fig. 3).

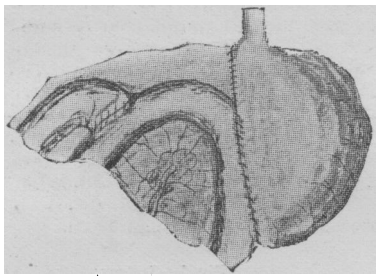

Fig. 3.—Lewitt.

With regard to the immediate mortality of the operation of partial gastrectomy, it may be pointed out that it has always been lower than that which occurred with the earlier partial colectomies, and yet allowed the latter operation to become firmly established. This is readily intelligible, since the danger of peritoneal infection is far less than in the case of the colon. Published records have stated the mortality as high as 30 per cent. and as low as 10 per cent., and with the development of more satisfactory technique it is steadily decreasing. The largest and most successful series published, that of Dr. W. J. Mayo, places the immediate mortality at 10 per cent. In my own experience the immediate mortality nearly doubles this figure. With regard to the permanent results to be obtained, no doubt these are to a certain extent vitiated by the fact that a definite proportion of the cases classed as carcinomata were really of a cicatricial nature. The investigation of Professor Alexis Thomson on this point has been already alluded to. Allowing this source of error, which with present knowledge must be a steadily decreasing one, the permanent results are as good as in any operation for malignant disease and better than most. Surgeons performing this operation have cases of five years' freedom from recurrence, while a considerable proportion of the patients undergoing the operation live much longer.

Dr. Mayo sums up the chances of the patient as follows: In operable cases a 90 per cent. chance of recovery from the operation exists, a 36 per cent. chance of three years' life, and a 25 per cent. chance of five years. This statement appears to furnish the ideal as the operation stands to-day.

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[1] *Quart. Journ. of Med.*, vi, No. 21, October, 1912. [2] Ibid., iv, No. 16, 1911. [3] *Archives of the Röntgen Ray*, October, 1913. [4] Collected Papers by the Staff of St. Mary's Hospital, Rochester, 1911. [5] BRITISH MEDICAL JOURNAL, October, 1910. [6] *Annals of Surgery*, June, 1912. [7] *Centralbl. f. Chir.*, No. 28, 1913. [8] Ibid., 1913. [9] Ibid., Nos. 26 and 32, 1911. [10] Loc. cit., No. 22, 1912.

DISCUSSION.

Mr. E. W. HEY GROVES (Bristol) said that in considering the difficulty in diagnosis there was great danger in the number and complexity of the new diagnostic methods now being put forward. Many of them took time, and none held out reasonable certainty of accurate diagnosis. In 20 to 30 per cent. they never could be certain of diagnosis—certainly not before exploratory operation. Valuable time might be lost while the patient was being kept under observation; this time should be occupied with an exploratory operation. A fallacy underlay the expectation that definite diagnosis could be made by chemical and physical means; it was assumed that every case was either definitely malignant or definitely benign. But they knew that many cases of malignancy had been benign or inflammatory. It was not reasonable to expect any test to definitely differentiate between these two conditions where the case was doubtful. The next point was the difficulty in diagnosis even after the abdomen was opened, and if such difficulty existed it was impossible to be certain by means of the gastroscope or test tube. He was doubtful if even the presence of apparent metastasis was sufficient to make diagnosis certain. In a case lately under his care there were in the quadrate lobe of the liver, in close contact with the stomach, two nodules which he regarded as metastatic growths. Pyloric obstruction existed, and gastro-jejunostomy was performed. Fortunately the patient refused further operation, and he now was in robust health, the nodules evidently not being malignant. He was formerly of opinion that in suitable cases the great omentum should, where possible, be removed with the growth. He was now more certain of that than ever; the only extension of the growth might be into the lymphatics of the great omentum. Its removal added very little to the difficulty of the operation.

Dr. T. KENNEDY DALZIEL (Glasgow) thought that concerning the diagnosis of carcinoma of the stomach they were in the same position as in the diagnosis of carcinoma in other situations, such as the breast. When the cancer ulcerated in the stomach changes in the gastric juice occurred which rendered the diagnosis suggestive. As soon as ulceration began they almost constantly found minute traces of blood in the gastric contents; that was a factor of great importance. He laid stress on the peculiar facies of these cases; it was not a certain guide but it was of some importance. In pyloric cancer they had, as a rule, symptoms of obstruction so direct that coming after a history of indigestion they should never hesitate to recommend immediate operation. Cancer of the body of the stomach might go on to great advancement without material symptoms showing themselves. He quoted the case of an aged lady who was found to have suffered for years from cancer of the body of the stomach, and whose only symptom was persistent flatulence. He deprecated the performance of a partial operation. For the past ten years it had been his rule fearlessly to remove the greater part or even the whole of the stomach. He did not approve of any operation which entailed tension, as in fixing duodenum to remains of stomach. They must try to avoid tension. He preferred end-to-end anastomosis of jejunum to oesophagus or small portion of stomach left. Operations on the stomach could be done confidently, as the possibility of sepsis arising from the contents was exceedingly slight, and fear of sepsis may be put aside. In the last five years he had performed forty-five partial or complete gastrectomies with the loss of only three cases; one from collapse after the operation, one from peritonitis due possibly to defective technique, and the third from thrombosis of abdominal veins. He had not infrequently removed the transverse colon with the stomach, but all the cases suffered recurrence. He would not remove the omentum as recommended by Mr. Hey Groves; he regarded omental infection as arising in consequence of infection of general peritoneum and the gathering up by the omentum of cancer cells. The results in reference to cure would be based on the same considerations relating to cancer elsewhere, and early and thorough operation would give results better than in cancer in other situations.

Mr. R. JOWERS (Brighton) thought that very few cases of early cancer of the stomach came into the hands of the surgeon. In the early stages there were no symptoms at all until mechanical or other causes gave rise to pain. He employed gastro-jejunostomy after closure of the ends of the stomach and duodenum. On one occasion he implanted the duodenal stump on the posterior wall of the stomach with satisfactory results. He had had no case which lived more than two years after operation.

Mr. A. H. BUCK (Brighton) said: With regard to the diagnosis of cancer of the stomach, the point which has impressed itself most firmly on my mind is the fact that there is a large proportion of doubtful cases in which, notwithstanding chemical tests, bismuth meals for the

purpose of *x*-ray photography, gastroscopes, and all the other methods of diagnosis at our command, the actual determination of the presence of carcinomatous cells can only be fixed by the microscope after removal of a portion or the whole growth by operation. More particularly does this apply to the earliest stages of carcinomatous growth. Of course I feel very strongly that in such cases the only point on which one should be dogmatic is their uncertainty. One has so often seen preconceived ideas upset at operations that I have been forced to the conclusion that early exploratory operations, with the determination to act as conditions found indicate, is the safest way of dealing with doubtful gastric cases in the best interests of the patient. Also there is the fact that one cannot—as I think Mr. Makins pointed out—possibly say what the extent of gland infection is without exploration. I would particularly mention that it is not only my own diagnoses that have proved wrong on operation, but those made by various physicians, some of them of worldwide reputation, who have had every opportunity with test meals and all the other diagnostic methods of coming to a correct conclusion. I have four times performed a preliminary gastro-jejunostomy and subsequently removed pyloric tumours believing them to be malignant. In each of these instances the microscope proved the tumour to be an inflammatory mass around a chronic ulcer. These cases have occurred during the last eight years. None of the patients had any further gastric symptoms, but one operated on eight years ago died this year of inoperable cancer of the rectum. In another case, five years ago, I found a movable pyloric tumour and performed a gastro-jejunostomy. Pylorectomy was advised but refused, but the patient came back to me in three months and asked me to do a further operation. On exploration I found that the mass had extended upwards and apparently into the liver and backwards to pancreas and abdominal vessels—that it was fixed and inoperable. I had to tell her that she was suffering from inoperable growth. The woman returned to her home in the country, and is alive and well to-day. I was certainly of opinion that this was a carcinomatous case, but now believe it to have been an infiltrating brawny chronic inflammatory mass. Six months ago I had to explore a gastric case where a very definite diagnosis of carcinoma of the body of the stomach had been made by a hospital physician who had had the patient under observation for five weeks, and, I believe, applied all the known tests except the gastroscope. This man had a pyloric tumour immovable on account of its fixity. After gastro-enterostomy he put on weight to 12 st., and is now perfectly well and following his occupation of blacksmith. I hope and believe the mass was inflammatory. But if there can be so much doubt after seeing the mass and having it in one's hands, and even, in those cases where one can remove the tumour, after cutting into it with a knife and examining the cut section with the naked eye, I do not believe that a correct diagnosis can be made in doubtful cases except with the microscope. If I had gastric symptoms myself which interfered with my daily life, and which did not yield to ordinary medicinal treatment, I should not hesitate to have an exploratory operation done, for whatever the results of various tests I should not be satisfied that there might not be grave mischief present, and, if there were, we know that operation is the only possible cure. The great trouble, as Mr. Makins pointed out, has been that one but seldom operates on carcinoma of the stomach sufficiently early. Complete removal of the stomach is, I believe, not such a serious and dangerous operation as might be imagined, provided the patient is in a fair condition when operated on. With reference to surgical interference with the pancreas, I might mention that I have removed the left half of that organ in a case of rupture without any bad symptoms supervening in a child of 5 years. In irremovable cancer cases gastro-enterostomy is, in my opinion, useless unless the opening can be made well on the cardiac side of the growth. When this has been impossible I have done an enterostomy and fed the patient by the bowel. The results, however, are, naturally, not very encouraging.

Mr. D. P. Dalbreck Wilkie (Edinburgh) referred to the dangers associated with the operation of pyloro-gastrectomy, more especially to the danger of leakage from the duodenal stump. He was convinced that this complication was usually due to a necrosis of the duodenal wall at the line of suture, owing to an interference with its vascular supply. It was noteworthy that this complication frequently occurred not in the cases where the duodenum was short and difficulty had been encountered in invaginating it, but in cases where the duodenum was comparatively lax and where great care had been taken in dealing with the stump. If it were borne in mind that the upper half of the first part of the duodenum was supplied by the supraduodenal artery coming from above and reaching the upper border of the duodenum about 1 inch beyond the pylorus, and that the anastomosis between the branches of this vessel and those of the other duodenal arteries was often particularly meagre, it would be seen that when an invagination was made within the area supplied by this vessel, the sutures were very liable to occlude the vessel itself at the upper border of the duodenal stump. From injection experiments on the cadaver, in which a pylorectomy was performed and the vessels were injected, he had found that a sufficiently nourished duodenal stump could be ensured in one of two ways—either by cutting the duodenum across close to the pylorus, so that the area of invagination lay proximal to the supraduodenal artery, or possibly better by dividing the duodenum ¾ to 1 in. from the pylorus, dividing the hepato-duodenal ligament and the supraduodenal vessels and then making a generous invagination of the stump, so that the final Lembert sutures were placed in vascular duodenum supplied by the pancreatico-duodenal branches.

Mr. McAdam Eccles (London) said: If surgery of the stomach in cases of primary carcinoma of the organ is to be radical and not merely palliative, early diagnosis is imperative. All are agreed that every means should be taken to endeavour to make the diagnosis admit of explanation, but also all will allow that much valuable time is often lost by non-operative treatment lines of diagnosis. Hence early exploration, as Mr. Makins has urged, is imperative. To certain points in this early diagnosis by exploration attention should be directed. Before exploration the consent of the patient should be obtained for any operation desirable. Supposing the abdomen is opened, what are the lines on which a diagnosis may be made? To my mind the first important point, when there is no tumour present, induration is of great value. This induration may be inflammatory solely, may be inflammatory *plus* malignant growth, or may be almost entirely carcinoma. Personally, I believe the correct procedure in cases of doubt is then to open the stomach on the proximal side of the induration, then to evert the affected area of the stomach wall through the gastric opening. It is possible now to see the mucous surface of the indurated part, and this inspection may show so suggestive an appearance of malignant disease that the diagnosis is settled. But supposing there is still a doubt, then a V-shaped piece of the affected area near, but not at its edge, should be removed and at once submitted to microscopical examination in a fresh section. If this reveals a carcinomatous nature, then there is a case in a stage the most favourable for a radical cure by excision. The proper procedure in such a case I believe to be (1) to excise widely the affected area, (2) to remove all glands in the three sets, whether these appear to be involved or not, and (3) usually perform a posterior gastro-enterostomy.

Mr. Betham Robinson (London) emphasized the fact that considerable difficulty might arise when the growth was in view as to whether it was of an inflammatory character or carcinomatous. He referred to a case in his own experience where there was a marked localized growth at the pylorus without adhesions and without glandular involvement. A preliminary incision was made on the stomach side and the growth inspected; there was seen hypertrophy and warty appearance of the mucous membrane, which was quite soft, and below this was felt infiltration of the pyloric wall, which was not nodular. As the condition was so suspicious of an early carcinoma it was decided to act on this suspicion, and pylorectomy was performed. The patient made an uneventful recovery. The histological report of the tumour showed that there was no sign of carcinomatous change in the mucous

membrane or tissue below. It was now sixteen months since the operation, and the patient was in perfect health.

The PRESIDENT drew attention to the utter unreliability of the free HCl test, and urged the attempt being made to excise gastric ulcers rather than do simple gastro-enterostomy. The difficulties after laparotomy of differentiating tumours need not trouble them; all should be removed.

Mr. MAKINS, in reply, said that he could not agree with Mr. Hey Groves in advocating removal of the omentum. The omentum was likely to be affected in carcinoma of the greater curvature of the stomach, and, if so, it was one of the most satisfactory places for cancer to appear, in so far as it gave rise to but little disturbance. Nor could he follow Dr. Dalziel in commending the removal of the whole stomach; he thought it sufficient to remove the lesser curvature. On the whole, there was no advantage in removing more than the amount of stomach involved. It was difficult to decide how far glands should be removed. He would be prepared to remove the growth alone, even though he could not remove the whole of the glandular implication. All the glands might not be carcinomatous, and therefore the patient should have the advantage of that chance. In regard to Mr. McAdam Eccles's recommendation to open the stomach itself to examine the growth from within in doubtful cases, he was personally opposed to such a proceeding in a case where he would simply have to stitch up that opening again. There was no harm in removing a tumour which proved to be simply an inflammatory one. The patient was better without it, so that if a tumour were present it should be removed, and there was no necessity to inspect it from within.

EXPERIMENTAL OBSERVATIONS ON THE CAUSE OF DEATH IN ACUTE INTESTINAL OBSTRUCTION.*

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THE high mortality which is still associated with operations for acute intestinal obstruction lends a peculiar interest to all investigations regarding the cause of death in such cases. Any advance in the treatment of acute ileus must be based on a more exact understanding of the relative importance of the various factors which make for a fatal issue in this malady.

In spite of the great amount of experimental work which has been carried out with the object of determining the cause of death in intestinal obstruction considerable diversity of opinion still exists regarding this subject, and it was by reason of this lack of concord in the results of previous observers that the present writer was induced to carry out the series of experiments with which this paper deals. The three theories which are at present held regarding the cause of death are:

1. That it is due to a secondary peritonitis.
2. That it is due to a splanchnic paresis, a draining of the body fluids into the portal area, followed by cerebral anaemia.
3. That it is due to toxaemia resulting from the absorption of poisonous products from the afferent bowel.

In discussions on this subject too little attention has frequently been paid to the distinction which must be drawn between simple obstruction of the intestinal lumen and obstruction *plus* interference with the blood supply of a segment of the gut. The classical experiments of Kader[1] showed how all-important is the latter factor, and in this paper these two fundamentally different types of obstruction will be dealt with separately.

Simple Obstruction of the Intestinal Lumen.

My experiments dealing with primary facts in regard to simple obstruction of the intestine I will merely mention, as they fully confirm the results of other observers. Thus I found that obstruction was more rapidly fatal the higher up in the intestine it was situated. This fact is most clearly brought out in dealing with an animal, such as the rabbit, which does not vomit. Thus, whilst an obstruction of the colon in this animal is survived for about ten days, an obstruction of the ileum is fatal in from four to five days, and one at the distal end of the duodenum in, on an average, seventeen hours. In the cat and dog, as also in the human subject, this difference is not so striking, but still holds good. My experiments also confirmed the fact so clearly shown by McClure,[2] that in the afferent bowel there is an enormous increase both in the number and in the virulence of the bacteria; and although this fact is most striking in low obstructions, it is also well marked in cases where the obstruction is situated high up in the small intestine. Also in regard to the question of peritonitis, my work confirmed that of all recent observers, with the notable exception of Borszéky and Genersich,[3] in showing that death usually results before any appreciable infection of the peritoneum has taken place. In the vast majority of my experiments, in which an accidental infection could be excluded, cultures from the peritoneal cavity were negative.

Perhaps the most striking feature in the *post-mortem* appearances in cases dying from simple obstruction is the accumulation of fluid in the afferent intestine and in the portal vessels, the scanty amount of blood in the systemic blood vessels, and the dryness of the skeletal tissues. Braun and Boruttau[4] maintain that in this drainage of the body fluids into the splanchnic area is to be found the true cause of death in obstruction of the intestine.

Toxicity of the Intestinal Content.

Nicolaysen[5] was the first to bring forward experimental evidence in favour of the view that toxaemia from the retained intestinal content was the cause of death in cases of obstruction. He collected the content from the afferent bowel in a case of acute obstruction in the human subject, filtered the content through a Chamberland filter, and injected the filtrate into the peritoneal cavities of a mouse and a guinea-pig. Both of the animals succumbed within twenty-four hours. Following this, elaborate experimental researches by Kukula[6] and Clairmont and Ranzi[7] appeared to establish the fact that toxic products developed in the afferent bowel, mainly as a result of bacterial activity, and that absorption of these poisons into the circulation accounted for the symptoms and the fatal issue in acute ileus. The theory of death from acute intestinal toxaemia has influenced very greatly the surgical treatment of the condition. At the present time many surgeons maintain that at operations for acute intestinal obstruction it is not sufficient to relieve the mechanical obstruction, but that measures must be taken to remove the toxic content which fills the afferent bowel, whilst many emphasize the danger of allowing the poisonous content to flood the empty efferent bowel, by which they maintain it is "greedily absorbed." It was imbued by this toxic theory that I commenced my investigations with the object of finding out how this toxaemia could best be combated. That such toxaemia could not be purely bacterial in nature was clear from the fact that death occurred earlier when the obstruction was situated high up in the relatively sterile reaches of the intestine than when in the ileum with its luxuriant bacterial flora. The work of Roger[8] and of Draper Maury[9] seemed to indicate that there were two types of death from obstruction of the small intestine—the one occurring in obstruction situated high up close to the duodenum, an auto-intoxication from some disturbance of the duodenal secretion; the other, met with in obstruction low down in the small intestine, an exo-intoxication bacterial in nature. I therefore carried out separate investigations in regard to simple obstruction at the high and low levels.

High Intestinal Obstruction.

This is met with in the human subject most typically in cases of gastro-mesenteric ileus resulting from pressure on the third part of the duodenum by the root of the mesentery either as a primary mechanical obstruction or secondary to a gastric paresis. The experiments of Maury, of Stone, Bernheim and Whipple,[10] and of Bunting and Jones[11] all pointed to there being produced, in cases of duodenal obstruction, some toxic body the absorption

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of which led to a rapidly fatal issue. The results of the two latter groups of observers also indicated that such a toxic substance was formed by the perverted activity of the duodenal mucosa and was independent of the biliary and pancreatic secretions. Whilst there can be no question as to the toxicity of the content of an obstructed duodenum when injected intravenously or intraperitoneally—I have repeatedly found such injections caused death with paralytic and spastic phenomena in a matter of from ten minutes to two hours—no conclusion can be drawn from such experiments, as Magnus Alsleben[12] has shown that the normal secretions from the upper part of the intestine injected in this way are highly toxic, more especially after a meal rich in protein. When the duodenum of a rabbit is obstructed in its distal part by a ligature death results in about seventeen hours. *Post mortem* the stomach is found enormously distended, studded with petechial haemorrhages, contains a thick mucoid acrid-smelling fluid, and shows numerous haemorrhagic erosions of its mucous lining.

In a series of seven rabbits I obstructed the distal end of the duodenum by means of a ligature, and at the same time drained the duodenum above this to the exterior by means of a rubber tube. The average duration of life in these animals was thirty-six hours, and during this time they lost more than a third of their body weight. As Matthews[13] had shown the vital importance of the duodenal secretion, I performed another series of experiments, in which, besides obstructing and draining the duodenum, I performed a jejunostomy and fed an extract of duodenal mucosa into the jejunum, but without appreciably prolonging life.

In another series of six animals I performed the same operation, but introduced at intervals through the jejunostomy opening the content from the duodena of rabbits which had died from simple duodenal obstruction, again with no appreciable effect on the length of survival of the animals. In a further experiment the content of the duodenum of a rabbit which had just died of duodenal obstruction was introduced into the duodenum and upper part of the jejunum of another rabbit without any obstruction being produced. This was carried out on two animals, but without producing the slightest effect on the health of either. I concluded from these experiments that the content above a duodenal obstruction was not markedly toxic when introduced into the intestine, and that the loss of fluid into the intestine, combined with the shock associated with the acute distension of the stomach and duodenum, might in great measure account for death. One could not exclude, however, a toxic absorption occurring as a late event after the distension of the duodenum had led to a loss of the vitality and integrity of its mucous coat.

Isolation of a Duodenal Loop in the Cat.

Stone, Bernheim and Whipple, experimenting with dogs, found that if a portion of duodenum, extending from just below the entrance of the pancreatic and bile ducts to the duodeno-jejunal junction, were isolated between two ligatures and a gastro-jejunostomy performed to preserve the continuity of the alimentary canal, the animals died within from twenty-four to forty-eight hours, apparently from an acute toxaemia. If the isolated duodenal loop were drained the animals survived for weeks. They found the content of such a closed loop, as also an extract of its wall, to contain a highly toxic substance which withstood filtration and heating at 60° C. for several hours.

I have repeated these experiments on cats, but with entirely different results. The following experiment was carried out on four cats:

Under chloroform and ether anaesthesia the abdomen was opened and two ligatures of fine rubber tubing were tied round the duodenum, the one just distal to the point of entrance of the bile and pancreatic ducts, the other just proximal to the duodeno-jejunal junction. A posterior gastro-jejunostomy was then performed. For the first three days after this operation the cats, with one exception, appeared well and showed little evidence of toxaemia, so much so that on the third day one of them was reopened to make sure that the ligatures had not cut through nor slipped. The ligatures were found to be firm and *in situ*, the duodenal loop being greatly distended and congested. This animal died on the following (fourth) day, and *post mortem* the striking feature was the extraordinary degree of fatty degeneration of the liver, which resembled that seen in delayed chloroform poisoning. There was no peritonitis. The duodenal loop was deeply congested, contained blood-stained, foul-smelling content, and its mucosa showed extensive ulceration along the antimesenteric border. In this case there was certainly evidence of a profound toxaemia, but one could not exclude a post-anaesthetic poisoning. The other cats lived for periods of three, six, and eight days respectively, and, although sleepy and apathetic, showed no evidence of profound toxaemia until within a short time of death. *In each case death was due to peritonitis the result of a necrosis of the duodenal wall* and leak at one of the sites of ligature. In no case did the liver show a marked degree of fatty change. In one case the mucosa of the duodenal loop was necrotic throughout; in the other two it showed areas of superficial necrosis and numerous haemorrhagic erosions.

The impression conveyed by these experiments was that whether the content of a closed duodenal loop in the cat be very toxic or not, it is apparently not absorbed freely in its toxic state so long as the mucosa is intact. To test this point further the following experiment was carried out on two cats:

Under ether anaesthesia a loop of duodenum was isolated by ligatures as in the previous experiments, but before tightening the lower ligature the loop was distended, by means of a needle and syringe, with the content of the duodenal loop of an animal which had just died from this form of duodenal obstruction. A posterior gastro-jejunostomy was then performed in each case. These animals therefore, started out with their duodenal loop filled with this possibly toxic content.

The one animal showed little or no evidence of toxaemia on the first two days following operation; on the third day it appeared somewhat apathetic, though it moved about and was certainly not acutely ill. It was killed on the fourth day, and *post mortem* there was found a generalized peritonitis due to a perforation of a necrotic area under one of the ligatures. The loop contained some solid material, evidently the residue of the content injected at the operation.

The second animal remained well for the first four days after operation and showed no symptoms of toxaemia.

On the fifth day it was obviously acutely ill and was consequently killed. At the *post-mortem* examination it was found that a perforation of the loop had occurred close to one of the ligatures. In neither case was there any noteworthy degree of fatty change in the liver.

These experiments demonstrated the important selective and neutralizing function of the intestinal mucosa, for until distension had interfered with the vitality of the mucous lining of the gut, absorption of toxic bodies was not noteworthy. In simple duodenal obstruction, therefore, where the mucous coat of the bowel remains more or less intact, I concluded that the acute symptoms are due as much, if not more, to loss of fluid as to absorption of toxic bodies. The fact that I was able to delay death in both cats and rabbits by subcutaneous saline infusions supported this view, whilst the work of McLean and Andries[14] and the results obtained by Hartwell and Hoguet[15] in duodenal obstruction in dogs fully confirmed it. These observers found that death could be delayed for several weeks if loss of fluid by vomiting and by the urine was more than made up for by copious subcutaneous saline injections.

Value of Subcutaneous Infusions.

If an obstruction of the distal end of the duodenum be produced in a cat, the animal presents symptoms closely resembling those of gastro-mesenteric ileus in the human subject—namely, thirst, lethargy, and occasional vomiting of large quantities of bilious fluid—the animal rapidly losing weight, and dying usually within seven days of the onset.

If, however, the animal be given daily by subcutaneous injection, a large quantity of saline, or, still better, a quantity of a 3 per cent. solution of dextrose in addition to the saline, not only will it show immediate improvement, but life will be prolonged for many days beyond that of a control animal. Clinical experience fully supports the experimental evidence of the supreme value of supplying the depleted systemic vessels with fluid in cases of high intestinal obstruction. Part of the value of the administration of large quantities of fluid must almost certainly be the enhanced secretory activity of the kidneys thereby produced. The impeded and sometimes almost arrested renal function which is met with in cases of high obstruction as a result of the depletion of the systemic circulation must itself constitute an important factor in producing a fatal issue.

Simple Obstruction of the Ileum.

A study of obstruction in the lower part of the small intestine of the cat throws much light on the relative

importance of the various factors making for death in acute intestinal obstruction. If the lower end of the ileum of a cat be cut across and both ends invaginated, the health of the animal does not appear at first to be much disturbed. For the first week after such an operation the animal will move about freely, eat readily though sparingly, will not, as a rule, vomit, and, apart from a loss of flesh and a gradual enlargement of the abdomen, will appear healthy. In a series of animals thus treated I found that the duration of life varied from eight to nineteen days (the animals were killed when grave symptoms developed). After the first week, the animals appeared somewhat apathetic and slept more than usual, but never exhibited any of the symptoms which we associate with acute intestinal obstruction. *Post mortem* in such cases enormous distension of the afferent bowel is seen. There is, as a rule, no peritonitis and little or no free fluid in the peritoneal cavity. The lower end of the afferent bowel is filled with solid, almost scybalous faecal matter, above this is foul-smelling liquid faeces. Microscopically, the mucous membrane of the distended bowel shows little change from the normal; as a rule, there is no evidence of ulceration, but when this does occur it is situated close to the obstruction. The liver and kidneys do not show any noteworthy degree of degenerative change.

Numerous experiments were made by injecting the intestinal content, filtered and unfiltered, boiled and unboiled, into other animals intravenously and intraperitoneally, and, although when injected in sufficient amount such content was markedly toxic, the surprising fact to me was the large amount which some animals would tolerate. I will not detail such experiments, as they are purely of scientific interest, not being comparable to anything which occurs in the human subject. The point of practical importance appeared to be to ascertain the extent to which toxic absorption occurs through the intestinal mucosa when the intestine is filled with obstructed content. I therefore carried out two series of experiments.

In the first series, the content from an obstructed small intestine was injected into the unobstructed small intestine of another animal. Eight experiments of this nature were performed, 5 on rabbits and the rest on cats.

In each case the abdomen was opened under ether anaesthesia, a loop of jejunum brought out and the abdominal cavity packed off with sterile gauze. A fine purse-string suture was then inserted into the wall of the gut, and into the centre of the area thus marked out the needle of a Record syringe was plunged, and the whole of the fluid content from the intestine of an animal dead from a simple obstruction injected. On withdrawing the needle the purse-string suture was tied and reinforced by one or two Lembert sutures. In spite of the utmost care to prevent soiling of the operative field, two of the animals died of peritonitis on the second and fourth days respectively. None of the animals presented symptoms referable to intoxication during the first twenty-four hours, and although two of the rabbits died of acute enteritis on the third and sixth days respectively, this was partly accounted for by the fact that in both cases the intestinal content had been injected cold.

In another experiment eight fluid ounces of intestinal content from a case of obstruction in a human being was injected into the small intestine of a dog, which showed few symptoms and made a prompt recovery.

The impression conveyed by these experiments was that the mucous membrane of normal intestine offers an effective barrier to the rapid absorption of large quantities of the products of intestinal putrefaction, and that the danger of absorption from the empty efferent bowel after the relief of obstruction has probably been exaggerated.

In order to gauge the relative importance of toxic absorption from the afferent bowel in bringing about the fatal issue, I carried out a second series of experiments, in which, having produced a simple obstruction at the lower end of the ileum, I filled the intestine above with the content of the small intestine of an animal which had died from a similar obstruction. I calculated that if toxic absorption had killed the latter animal, and if the former started out with its obstructed intestine filled with toxic content, symptoms of toxaemia should very quickly supervene, for, as Enderlen and Hotz[16] have pointed out, the active peristaltic movements which characterize the early stages of an obstruction tend to accelerate absorption, whilst the work of Clairmont and Ranzi, and of Braun and Boruttau clearly proved that absorption from obstructed intestine becomes very slow in the later stages.

This experiment was carried out in six animals, and again one was met by the difficulty of preventing peritonitis, the least soiling of the peritoneum with the highly infective content leading to a fatal peritonitis. The animals survived for periods varying from two to seven days, four of them dying of peritonitis. In no case was there evidence of any marked toxaemia within the first thirty-six hours, and, as in the previous series of experiments, the impression conveyed was that absorption of the content of obstructed intestine through healthy intestinal mucosa does not lead to acute toxic symptoms.

The outstanding difference between high and low intestinal obstruction in cats is that in the former a large amount of fluid from the actively secreting upper part of the intestine is lost by vomiting, whereas in the latter the fluid of the secretions of the upper part is reabsorbed lower down and life is consequently prolonged. Absorption of toxic bodies in simple obstruction is a slow process, and does not lead to the symptoms of acute ileus. In the surgical treatment of simple obstruction, infection and not toxaemia from intestinal absorption is the danger to be guarded against.

Obstruction of Lumen plus Interference with Vascular Supply.

As the majority of cases of acute intestinal obstruction which come under the care of the surgeon belong to this group, it requires the most careful study. In spite of Kader's work many of the later observers have ignored the paramount importance of the vascular factor in producing the typical symptoms of acute ileus. In this class of case the symptoms are much more dramatic than those met with in simple obstruction, to which they bear little resemblance. Albeck[17] and Murphy and Vincent[18] among recent investigators are the only workers who have given due weight to the essential difference between the two conditions. As a result of the experiments which they carried out they came to the conclusions that in cases where a loop of intestine was strangulated, death resulted from toxaemia from the absorption of poisons generated within the strangulated loop. Albeck believes that such poisons belong to the putrefactive class, whilst Murphy and Vincent maintain that they are bacterial toxins.

I have carried out a series of experiments on cats with the object of determining what part toxaemia played in causing the symptoms and the fatal ending in cases of strangulation of the intestine. In my earlier experiments I found that the method of strangulating a loop of intestine by a rubber band or similar contrivance was too uncertain. I found, as did Murphy and Vincent, that obstruction of the venous return was the most important factor in producing an early fatal result, and that the complete necrosis of an isolated loop of intestine resulting from a ligature of both its arteries and veins was survived for a considerably longer time than was the haemorrhagic infarction which resulted from a ligature of its veins alone. I therefore took as a standard operation the isolation of the lowest 12 to 20 cm. of ileum by tightly ligaturing the intestine at either end with a rubber band, and then ligaturing the veins returning from this loop. The symptoms following this operation were very similar to those met with in cases of acute internal strangulation in the human subject, and death resulted in, on an average, thirty hours. *Post mortem* the loop was found to be of a deep prune colour, tensely distended with foul-smelling blood-stained content, which swarmed with bacteria. The surface of the loop was covered with a fine layer of fibrin, and cultures from this in the majority of cases gave a growth chiefly of *B. coli*. The peritoneal cavity contained a large quantity of blood-stained exudate, the mesenteric veins were engorged, and although the intestine proximal to the strangulated loop was not distended, the total amount of fluid collected in the splanchnic area was very striking. Microscopic sections of the wall of the affected intestinal loop showed that the mucous membrane was almost completely destroyed, the cells being disintegrated and having lost their staining properties. If death were due mainly to absorption of toxic bodies from the strangulated loop, this must occur by one or both of two channels—namely, by the lymphatics from the loop or through the peritoneal cavity. In five animals I ligatured all the lymphatics as well as the veins from a portion of ileum isolated between two ligatures, but found that lymphatic obstruction did not affect the length

of survival of the animals to any appreciable degree. Absorption of toxic products, if it occur, must take place, therefore, mainly through the peritoneal cavity.

In six cases of venous obstruction I collected all the fluid from the peritoneal cavity, and injected it intraperitoneally into six other cats. In no case was there evidence of toxaemia, and all six cats survived. This, of course, only proved that there was not sufficient toxin in the peritoneal fluid at the time of death of the obstructed animal to produce symptoms on injection, and did not preclude a steady continuous absorption, the cumulative effect of which was sufficient to produce toxaemia and death. The content of the loop in such cases was next examined as to its toxic properties. It was found that the intraperitoneal injection of even small amounts of the unfiltered content produced rapid death from a virulent peritonitis and septicaemia.

In five cases the content of the loop was filtered through a Berkefeld filter, and then injected intraperitoneally into cats. In no case was there any marked evidence of toxaemia, and the animals all survived, although in three cases they lost weight considerably for several weeks after the injection.

In order to test what degree of toxic absorption may occur in the human being when a strangulated loop is allowed to empty its content into the intestine below, the unfiltered content from a venous obstruction loop was injected into the intestine of another animal above a simple obstruction of the ileum. This experiment was carried out on three cats. In spite of elaborate precautions to prevent soiling of the peritoneum, two of these animals died of a virulent peritonitis. The result in the third animal was very interesting: it showed no immediate toxic symptoms and lived for fourteen days—that is, slightly over the average duration of life for a simple obstruction.

I concluded, therefore, that whilst the content of a strangulated loop is highly infective, it does not cause toxic symptoms when absorbed through healthy intestinal mucosa, and that passing it through a Berkefeld filter removes any toxic bodies that it may contain as tested by intraperitoneal injection. The question then arose, Is death due to poisoning, not so much from the content of the loop as from absorption of autolytic poisons developed in the infarcted bowel wall itself? To test this question the affected loop in cases of venous obstruction, after being emptied of its content, was put into a hydraulic press and subjected to a pressure of 3,000 lb. to the square inch; the juice thus expressed was collected, passed through a Berkefeld filter, and injected intraperitoneally into cats. This experiment was carried out on five cats, but in no case did the injection cause more than a trifling and passing indisposition, all the animals recovering. I concluded, therefore, that poisoning by an autolytic toxin could play but a small part in causing death in such cases of obstruction.

In a fourth series of injection experiments I tested what was the effect of the combined injection of the three filtrates—that is, the peritoneal exudate, the content of the loop, and the pressure extract of the wall of the loop. This was tested in four cats; two of them recovered (one of these was definitely indisposed for forty-eight hours after the injection), the other two, although exhibiting no immediate toxic effects, died from peritonitis some days later, this being due to imperfect filtration of the fluids injected. Finally, to test whether there was any toxic body in the circulating blood of an animal during the later stages of a venous obstruction, I connected up the carotid artery of such an animal to the jugular vein of a healthy cat (50 c.cm. of blood having been previously removed from its saphena vein) and transfused the blood of the obstruction animal into the healthy one. On coming out of the anaesthetic the latter showed no evidence of toxaemia and made an uneventful recovery. The results of these experiments convinced me that toxic absorption from the strangulated intestine is not the primary cause of death in cases of internal strangulation, and whilst fully sensible that they did not exclude toxaemia as being a factor in many cases, they still pointed to shock and splanchnic paresis being the chief factors in producing the symptom-complex in cases of acute strangulation. This point was made especially clear in one experiment where, in an unusually large and powerful animal, the venous return from 50 c.cm. of small intestine was interfered with and this portion of bowel isolated by ligatures, the animal dying in five hours with typical symptoms. In this case cultures from the peritoneum were negative, as were also injection experiments with the peritoneal exudate, intestinal content, and the extract of the wall of the infarcted loop.

In cases surviving for more than twenty-four hours the factor of peritoneal infection comes in and may constitute the ultimate cause of death in such cases.

Conclusions.

1. Simple obstruction of the intestinal lumen must be clearly distinguished from strangulation. In the latter, death ensues long before the obstruction to the onward passage of intestinal content has become a factor of importance.

2. Simple obstruction high up in the intestine differs from that lower down, chiefly in the great loss of intestinal secretions by vomiting in the former, compared with the latter, where the secretions are reabsorbed above the obstruction.

3. Absorption of poisons from the content of the obstructed intestine is not the leading factor in producing the symptoms of acute ileus.

4. The danger of allowing the content pent up above an obstruction to flood the empty intestine below has probably been exaggerated.

5. Peritonitis plays no part in causing death in the majority of cases of simple intestinal obstruction; in cases of strangulation, however, it may undoubtedly be a factor in the later stages.

6. In all varieties of intestinal obstruction the bowel content is highly infective.

7. Splanchnic paresis with depletion of the systemic circulation is the main factor in producing the symptom-complex of acute intestinal obstruction. In treating this factor, besides the operative relief of the obstruction, copious subcutaneous infusions of saline and dextrose solutions are of immense value. Clinically, the administration of pituitrin is found to be a valuable adjuvant.

8. The prompt relief given by enterostomy in cases of simple obstruction of the small intestine in the human subject is to be explained, not so much by the relief from toxic absorption as by the breaking of a vicious circle, the intestinal distension causing a paresis of the splanchnic vessels, and vice versa. By relieving the intestinal distension the splanchnic vessels are allowed to regain their tone, and the depletion of the systemic circulation is arrested.

9. The operative treatment of intestinal obstruction should be as conservative as possible; only on imperative indications should the intestinal lumen be opened. The danger of a post-operative peritonitis from the slightest soiling is much greater than that of toxic absorption from a loaded bowel.

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RADIUM AND INOPERABLE CANCER.

By A. A. Warden, M.D.,
Paris.

The surgeon is a little apt, once he has committed himself to the opinion that a case of cancer is inoperable, to add that it will probably be best to attempt no treatment whatsoever. He has a wholesome disbelief in non-surgical measures, and classes among uncertain remedies Coley's fluid, radium, diathermy, etc. In other words, his attitude is orthodox and conservative, for the fiat has gone forth

that the only officially recognized treatment of cancer is the knife, and the knife as early as possible.

Now it seems to me that this phrase—that a cancer is inoperable—requires consideration, and perhaps some qualification. What is an inoperable cancer? Does the surgeon mean merely that in his opinion an operation is not advisable because likely to be followed by speedy recurrence, or does he mean that it is literally impossible, without undue risk to life, to perform any operation? From the patient's point of view the term "inoperable" may have a different meaning, for he may decline to submit to the vast mutilation that some surgeons still—and with good results in many cases to support them—feel themselves justified in recommending. For example, a patient has a small buccal or lingual cancer. The surgeon consulted thinks it quite operable, and suggests excision of the upper jaw or complete removal of the tongue. The patient declines, for he prefers, if necessary, death to such deformity. In other words, his cancer, to him, is inoperable—nor, indeed, can we blame his decision.

The term, therefore, does not seem to admit of strict definition, but must vary in its sense with the judgement and experience of each surgeon. Perhaps the simplest and least objectionable meaning to be attached to it would be that a cancer must be considered inoperable or operable in unfavourable circumstances when there is extensive glandular infection. Wide extension to glands of a cancerous process implies conditions of time and distribution that make it of very grave import.

If the cancer, then, be considered inoperable, is there any resource other than surgery, or is the outlook altogether hopeless?

Five years' experience has shown me that radium is worthy of recognition by every surgeon and physician who may be called to deal with an "inoperable" cancer. I ask the consultant surgeon not to confound inoperable with hopeless conditions, but to remember that radium-therapy, although in its infancy, has already proved its value in such cases. No reasonable man who takes the trouble to follow the records that have been published in different parts of the world can doubt that radium has won—next, perhaps, to the bistoury—the highest place in our therapeutic armoury.

In Paris, my friend Dr. Chéron and Dr. Rubens-Duval published last year a case of inoperable uterine cancer cured by radium. I use the word "cured" advisedly, for fifteen months later the patient died of a disease of the central nervous system, and the autopsy verified the clinical evidence of the complete disappearance of all cancerous tissue. Some details of this case were given in the *Lancet* of November 16th, 1912.

Ten further cases of uterine or vaginal cancer have been reported by these authors in which there has been, clinically, complete disappearance of the growth. Eight of these patients are alive and well one, two, and four years after the cessation of all treatment. These results are confirmed by Léjars, the well-known surgeon, and others.

I have had under my care a number of cases of advanced cancer—all so proved by microscopic examination—that have been known to exist for periods varying from nine to eighteen months, and that, accompanied by extensive glandular involvement, have rightly been considered inoperable. In almost every case the use of radium, alone or combined with surgical intervention on the glands, has resulted in the complete disappearance of the original tumour. Sometimes there has been no recurrence; the longest case in my mind, to which I shall refer more fully in a moment, is a squamous epithelioma of the mucous membrane of the lip under the care of Professor Gaucher and Dr. Dominici, inoperable, but well under radium treatment since February, 1908—that is, over five years later. Sometimes, although the initial lesion disappears, the glands can only be incompletely dealt with, and the patient succumbs to generalization. Sometimes, when a local cure has apparently been effected a metastatic growth in the vertebrae, or in an abdominal organ, makes its appearance. Sometimes there is recurrence, so-called, some months later, in contiguous tissue.

Considering that in these cases the radium has been applied after the cancer cells have been circulating in the lymphatic system for from nine to eighteen months, such results can scarcely be laid to the discredit of the therapeutic agent. It is possible no blame can be placed anywhere; but if there is any to be apportioned it is surely to the delay in the recognition of the cancer as finally inoperable, and in reaching the decision that the case is at last suitable for the radium expert.

It is surely evident that such reasoning is neither logical nor just. The squamous epithelioma of the mucous membrane of the lip, to which I refer above, occurred in a patient shown by Dr. Dominici and myself at a demonstration given before the Radiology Section of the British Medical Association in London in July, 1910. This patient (see photograph and special plate, BRITISH MEDICAL JOURNAL, August 27th, 1910) was treated in December, 1907, and was well in February, 1908, and now, in the spring of 1913, or over five years later, remains perfectly well with the mucous membrane of the lip completely restored and normal in appearance.

As I have referred summarily to what may fairly be termed a definite cure of cancer by radium, let me also give, as briefly as possible, notes of what might be termed a failure, in that, within the year, there has been "recurrence" or rather a fresh outbreak, close to the original lesion.

In May, 1912, a patient was sent to me to Paris by a distinguished London surgeon. He first had sore-throat with a definite pharyngeal lesion, not, however, then recognized as cancer, in March, 1911.

In October, 1911, glands enlarged on the left side of the neck, and, six months later, suppurated, were opened, examined histologically and found to be squamous epithelioma. The primary lesion, an ulcer situated between the epiglottis and the side of the pharynx, was then detected and other glands noted in the neck. On his arrival in Paris, therefore, we had to deal with a carcinomatous lesion of at least fifteen months' standing, inaccessible to surgery and complicated by extensive lymphatic infection.

In consultation with Drs. de Martel and Dominici our treatment was by a combination of radium-therapy and surgery. A platinum tube containing 40 mg. of radium was introduced into the base of the tongue through a small submental incision, and, after the anterior triangle of the neck had been cleared of the glands and cancerous tissue including part of the sterno-mastoid muscle, three other tubes were left to irradiate the tissues of the neck. These four tubes were removed thirty-six hours later. The wounds healed rapidly and, a month later, the complete disappearance of the tumour was certified by three eminent throat specialists, among them the authority who had originally discovered the lesion.

Nine months later the patient's condition remained excellent, and hopes of complete recovery were held by all familiar with the details of the case.

In April, 1913, that is, ten months after the treatment, further malignant processes were found in the throat—namely, ulceration the size of a sixpence, at the base of the tongue and along the left border of the epiglottis, an inch distant from the original lesion. Under cocaine the epiglottis was removed, and the microscope showed the cancer cells extending deeply into its cartilage. The lingual ulcer was dealt with by the introduction into the base of the tongue, through small lateral incisions in the neck, of two tubes of radium of 45 and 25 mg. A month later the most careful search again failed to detect any sign of malignant disease, and the patient is to-day in full enjoyment of his usual strength.

Even admitting such a case to be, however, a failure in that recurrence took place, it may justly be claimed for radium:

1. That the original tumour disappeared.
2. That the neck remains free from evidence of lymphatic infection; and
3. That the patient is still enjoying healthy activity a year after a hopeless verdict had been pronounced, and more than two years after the first evidence of cancer.

CHRONIC INTERSTITIAL ENTERITIS.

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I HAVE pleasure in drawing your attention to this condition, which, I think, has not yet been fully described.

Twelve years ago I saw a professional colleague, suffering from obstruction of the bowels of a fortnight's duration.

previous to which he had had for several weeks numerous attacks of colic, slight attacks of diarrhoea with no tenderness over the abdomen, and very slight rise in temperature, with no appreciable alteration in the pulse-rate. When seen by me the abdomen was not distended nor were the muscles rigid, but to the hand gave a sense of putty-like resistance. As vomiting was persistent, I concluded that there might be an obstruction high up, and so opened the abdomen, to find the whole of the intestines, large and small alike, contracted, rigidly fixed, so that when a loop was lifted from the abdomen it sprang back into its sulcus. That the wall of the whole intestine was chronically inflamed there was no doubt. In parts the peritoneum seemed oedematous, as was also the omentum and mesentery, in which the glands could be felt enlarged. Nothing could be done to restore the function of the canal, and the patient died a few days afterwards.

We were not then familiar with the condition, and it was supposed to be tuberculous, though this was negatived by microscopic examination, the only information we obtained from the pathologist being that the condition was a chronic and inflammatory one. A few years later, with Dr. Gibb of Paisley, I saw an exactly similar condition in a young man of 32. His symptoms were somewhat more acute than the previous case, but practically the same. He also died. No examination was allowed.

In these two fatal cases the disease involved the whole of the small and large intestines. The following cases being localized, and therefore excisable, permitted operation, and excision of the affected portion was in all cases followed by complete restoration to health.

The first of these cases I saw with the late Professor Gemmell in 1905.

Mrs. T. was admitted to the Western Infirmary with symptoms of partial obstruction, and one could palpate a coil of intestine, rigid and thickened. Treatment was of no avail, attacks of pain becoming more frequent; progressive emaciation and general malaise led to operative interference, when a portion of jejunum over 2 ft. in length was found to be affected and was excised, with perfect recovery. I removed in two cases the caput coli and adjoining portion of the ileum.

In another case the sigmoid, and in another the transverse colon, and, lastly, from a child of 10 a specimen which well now indicates the great thickening of the bowel wall. This specimen was from the middle of the ileum.

The following is the pathological report of the condition from the laboratory in the Western Infirmary, on the specimens obtained from the ileum, jejunum, and colon.

Pathology.

Histologically there is much in common in the three cases, indeed they form a graded series in which all the stages from acute to chronic may be traced. The most acute lesions are found in Master W. G., and the most chronic in Mrs. N. The following description is based upon a study of numerous sections from each case.

The earliest change in the bowel appears to be that of acute congestion. The vessels throughout are dilated, and there is much oedema of the submucosa. As evidences of the acute inflammation, the vessels are seen to be rich in polymorphs, and there is considerable infiltration of all the coats with similar cells. Here and there, too, in mucosa and submucosa irregular haemorrhages have occurred. These changes also implicate the mesentery in a lesser degree. It is noteworthy that the lymphoid aggregations are singularly free from pathological change.

With increasing infiltration the next phase arises, namely, cellular and fibrinous exudation within the gut lumen (bile-stained naked eye). Still later the mucous membrane is denuded of epithelium, and, the muscularis mucosae being obscured by infiltration and necrosis, the appearance is that of a few islets of glandular tissue lying in a semipurulent collection which abuts upon the much altered submucosa. There is, however, no great sloughing of the bowel wall, and the muscle is not laid bare, indeed it is in a way protected, as shown by a new formation of capillaries in the more superficial layers of the submucosa.

In the specimen from Mrs. T. the regenerative process is in the ascendancy, although the condition is still fairly acute. The serous and muscular coats are slightly oedematous, markedly congested, even slightly haemorrhagic, and considerably infiltrated with both polymorphs and mononuclear cells. The submucosa is also oedematous and infiltrated, mononuclear cells, however, predominating. The muscularis mucosae is definable as the outer limit of a broad zone of young granulation tissue which is evidently replacing the now thin layer of purulent exudate within the gut lumen.

A still further advance in the healing process is seen in the sections from Mrs. N. There is scarcely any purulent exudate within the lumen, it and the mucosa having been replaced by granulation tissue in which the vessels are numerous and well formed, and fibroblastic transformation is well marked. There is less oedema of the tissues than in the two previous cases, and though leucocytic infiltration of all the coats is still great, it is definitely a mononuclear one. Further, there is a notable number of eosinophiles throughout, and a few giant cells are also present in the granulation tissue.

From the acute case, Master W. G., coliform bacilli were isolated in pure culture from the depths of the affected bowel wall under circumstances which suggest an etiological relationship. They are also demonstrable in suitably stained sections.

A careful search has failed to reveal micro-organisms of any kind in the depths of the other two cases—the ordinary bacterial flora of the gut alone visible in the most superficial part of the exudates. The symptoms in all the cases were similar; the characteristic and most striking feature being most violent colic, causing vomiting and occasionally an escape of some blood, also constant mucus from the bowel. The bowel becoming exhausted, or the contents being forced through the rigid portion, the patient then would be at rest, quite comfortable and cheerful for a time. In the case of the child even ten or twelve hours might elapse between the attacks of pain, which were truly distressing in their intensity. In the young one would naturally suspect intussusception, except that the obstruction was not complete, while the intensity of the pain put a chronic intussusception out of the question. Above the affected portion of the bowel peristalsis could be observed. During a painful attack the inability to retain food and the constant suffering leads to steady emaciation, the temperature only occasionally rises and during the intervals of pain, and the pulse is quiet. In all the cases one could determine an area of resistance in the colon and sigmoid, naturally giving rise to the supposition that we might have to deal with a diffused and malignant growth. As far as I am aware, the prognosis is bad except in cases where the disease is localized, and even there seems rather hopeless unless operation be had recourse to.

Etiology.

In regard to etiology, we have no direct clue by histological or pathological examination. The cases gave the impression that they were probably tuberculous, and yet from the uniform character of the affection it evidently is not so. The affected bowel gives the consistence and smoothness of an eel in a state of rigor mortis, and the glands, though enlarged, are evidently not caseous.

In vol. xx of the *Journal of Comparative Pathology and Therapeutics*, McFadyen draws attention to Johne's disease, a chronic bacterial enteritis of cattle which was called pseudo-tuberculous, in which the histological characters and naked-eye appearances are as similar as may be to those we have found in man. The condition was first described by Henny and Frothingham in 1895, since which time numerous observers have noted its course in various parts of the Continent, and McFadyen examined 6 cases found in England in 1911. McFadyen, however, describes an acid-fast bacillus similar to but demonstrably not the tubercle bacillus, differing in size, and also as not giving rise to tuberculosis in guinea-pigs. This bacillus is found not only in the tissues but also on the surface of the mucous membrane, which in animals seems to be more affected, presumably because they die earlier, than in man, so that the disease is not so advanced. In my cases the absence of the acid-fast bacillus would suggest a clear distinction, but the histological characters are so similar as to justify a proposition that the diseases may be the same. As far as I know the disease has not been previously described, but it seems probable that many cases must have been seen and have been diagnosed as tuberculous, and possibly nothing done for their relief.

Treatment.

In regard to treatment, these cases which have come under observation have pursued their course uninfluenced by dietetic or medicinal treatment, and apparently only operation can afford relief, and then only if the disease be limited. Seven out of the nine made a perfect recovery after the operation, and one does not hesitate in resecting large portions of the intestine. The subject has been one of great interest to me for some years. My friends the pathologists prefer to call it hyperplastic enteritis, and I can only regret that the etiology of the condition remains in obscurity, but I trust that ere long further consideration will clear up the difficulty.

Another specimen I obtained recently from a patient of Dr. Revie of Kilmarnock.

A lady on whom I had performed colostomy on the right side a year previously, with the object of arresting the intestinal current to enable us to freely flush the diseased colon. The symptoms were those already described with an exaggerated degree of pain, and persistent, most painful diarrhoea with blood and mucus. Distinct improvement ensued from the colostomy and lavage, though during the year she had on two occasions exacerbations. When seen at the end of the year she had been extremely ill again for one month, and was so evidently losing ground that I advised complete removal of the colon, which colon shrunk to its present dimensions as I now show you. The histological characters are similar to those found in the previous specimens. The patient has made an uninterrupted recovery so far, and I hope at no distant date to transplant her caput coli (which alone was unaffected and was left) to her rectum.

An interesting fact in this case is that on the removal of the colon it was immediately sent in a sealed vessel to the pathologist, and he failed to discover micro-organisms either on the surface of the mucous membrane or in the tissues, indicating that lavage had been thoroughly effective in purifying the canal, in spite of which lavage, however, the disease had steadily progressed. Indeed, from the first operation the disease had extended upwards from below the hepatic flexure to near the caput coli.

DISCUSSION ON THE DIAGNOSIS AND TREATMENT OF INJURIES OF THE KNEE-JOINT OTHER THAN FRACTURES AND DISLOCATIONS.

OPENING PAPERS.

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IN the first place I must thank the President and Council of the Surgical Section for the honour they have done me in asking me to introduce the discussion on the diagnosis and treatment of injuries to the knee-joint other than fractures and dislocations. I can assure you it is an honour I greatly appreciate, and I sincerely trust that the subsequent discussion will prove both interesting and profitable.

It has been somewhat difficult for me to decide upon the form in which I should treat the subject, but, after considerable thought, I have come to the conclusion that the clearest and best method will be to exclude such conditions as perforating wounds and their effects, and confine myself to what one might term subcutaneous injuries. Among these are simple traumatic synovitis and arthritis, more or less severe lacerations of important ligaments, haemophilia, some forms of loose bodies, injuries, sometimes trivial, to joints already affected with disease, such as osteo-arthritis and torn semilunar cartilage.

Anatomy.

Before considering these injuries seriatim, I think it would make the subject clearer if I briefly mentioned some of the more important features in the anatomy of the knee-joint, particularly those which have a bearing on my subsequent remarks. This joint, besides being the largest, is the most complicated articulation in the body, and possesses important extrinsic and intrinsic ligaments. Included in the former are the anterior or ligamentum patellae; the internal lateral, which is a broad, flat structure; the cord-like external, and lastly, the posterior. The chief intrinsic ligaments are the anterior and posterior crucial. Also contained in the joint, and in close relationship to the articular surface of the upper end of the tibia, are the two important semilunar cartilages. These are two crescent-shaped pieces of fibro-cartilage, the internal being applied to the upper surface of the internal and the external to the upper surface of the external tuberosity of the tibia. The internal forms a larger segment of a circle, and is less movable than the external. Its posterior end is attached to the back part of the intermediate rough area on the upper end of the tibia in front of the attachment of the posterior crucial ligament, and the anterior end is attached to the front of the intermediate rough area just in front of the anterior crucial ligament. Its circumference has a firm attachment to the deep surface of the internal lateral ligament, and a somewhat weak connexion, by means of the coronary ligament, to the upper end of the tibia. The external cartilage forms a smaller segment of a circle than the internal, and takes up a smaller space. Its anterior extremity is fixed to the intermediate rough area in front of the tibial spine, while its posterior end is connected to the tibial spine between the two tubercles, giving a strong slip to the posterior crucial ligament. It has no attachment to the external lateral ligament, being separated from this by the tendon of the popliteus muscle, but it has a weak connexion with the upper end of the tibia by means of the coronary ligament. The external semilunar cartilage therefore has a decidedly looser attachment than the internal, and this circumstance, as I will show later, is the cause of the greater frequency of tears or splits of the internal semilunar cartilage.

The knee is not a simple hinge-joint, as at the end of extension and the beginning of flexion there is a distinct twisting movement of the femur on the tibia. This is brought about by the fact that the articular surface of the internal condyle is longer by a third than the corresponding surface of the external. Thus, in the movement of extension, following upon acute flexion, after the articular surfaces on the external and posterior two-thirds of the internal condyles have glided over the corresponding parts of the articular surfaces of the tibia, any further movement must occur in the anterior oblique third of the internal condyle. In consequence, this condyle twists or screws inwards, and at the end of extension the joint is securely locked. Thus, the femur and tibia become practically one continuous rigid support; no lateral or rotatory movements being possible, and the following ligaments—namely, the internal lateral, anterior crucial, and posterior—become taut and tense. When, however, flexion takes place, a certain amount of rotation and lateral mobility is possible, varying in degree with the amount of flexion. Whereas, therefore, in the case of a fully extended knee-joint, no rotation is possible, except there be tearing or stretching of important ligaments, in the case of the flexed position a certain amount of rotation and lateral movement is possible, and hence there is greater insecurity. It is in this flexed position that tearing or splitting of the semilunar cartilage takes place.

In a paper which I read on October 8th, 1912, before the Royal Society of Medicine, after stating that the occupation of coal-mining far outnumbered all others, in the district of Northumberland and Durham, in supplying the vast majority of sufferers from this accident, I mentioned that the coal-miner, owing to the lowness of the seam at which he is hewing, performs his work with his knees more or less flexed—in a position, therefore, in which a certain amount of rotation and lateral mobility, between the upper end of the tibia and the lower end of the femur, is permitted. If, while the knee is in this position, a forcible twist or wrench takes place, the semilunar cartilage, nipped between the condyle of the femur and the upper end of the tibia, may be forcibly dragged towards the centre of the joint, and either split more or less in a longitudinal manner, or have its free edge torn or frayed.

This conclusion, which was based upon a personal experience of 449 cases in which operation had been performed, and in which great care had been exercised in taking the history of the patients, is, I am aware, directly contrary to that of Mr. Albert Walton, who is of opinion that forcible extension is the cause. I may mention, however, that his opinion is based mainly upon anatomical grounds and experiments on the cadaver.

I would here urge that in all cases of injury to the knee joint accurate inquiry should be made into the story of the accident and the subsequent history, as, when the

patient comes before the surgeon, most probably no objective symptoms, beyond perhaps the presence of fluid in the articulation, are present, and to gauge the extent of any intra-articular lesion you are compelled to depend on the answers given to your inquiries.

Under the term "traumatic synovitis" I am including those cases in which, after injury, there is an acute effusion of more or less extent into the joint, but no extensive injury to any of its ligaments or to the semilunar cartilages; consequently the stability of the joint is not in any way permanently affected. It is true that in a large effusion, with consequent stretching of ligaments, some lateral mobility of the joint in the extended position is possible, but when the effusion has disappeared this disappears also. If simple acute synovitis be treated immediately after the accident by rest, and perhaps by the application of cold, the condition quickly improves, and when pain and tenderness have subsided, moderate exercise should be encouraged to aid in dissipating the effusion. In some few cases the effusion becomes chronic, but when this occurs elastic pressure with moderate exercise will, as a rule, effect a cure.

Where there has been extensive injury to the important ligaments accurate diagnosis is very important, as in the absence of this correct treatment will be impossible, and the result will be probably a very much weakened articulation. Probably the most common is that in which, in consequence of forcible hyperextension, rupture of the posterior, back of the internal lateral, and anterior crucial ligaments has occurred.

In April, 1911, in an important League match under Association Football rules, a famous centre-forward, after beating the opposing backs, was making for goal with the ball at his toes. The goal was apparently at his mercy, when the goalkeeper rushed out, fell on to his knees, and endeavoured to pick up the ball. In doing this he "chocked" the forward's right knee, and prevented it being bent. As a result, the body momentum going onwards, and the knee being incapable of flexion, a large degree of hyperextension took place, leading to extensive tearing of the ligaments normally preventing this. I possess an instantaneous photograph, taken at the psychological moment, which aptly illustrates what actually occurred.

When I saw him, a few minutes after the accident, he was in extreme pain, the knee-joint was very much swollen, and hyperextension was possible to an angle of 45 degrees beyond the normally fully extended position. An *x*-ray photograph showed that there was no injury to the bone. He was treated by splinting the injured knee in a slightly flexed position for three weeks, and during this time he was confined to bed. He was then allowed to get about on crutches, the limb being encased in poroplastic splints and the joint still kept in the slightly flexed position. After three months had elapsed, passive movements were cautiously commenced. Necessarily, of course, treatment was both prolonged and tedious, but in the end a good result was attained, sufficient to allow him to return to first class football.

In other cases, in consequence of forcible abduction or adduction, tearing of the external or internal lateral ligaments respectively may result, and, if proper repair does not take place, a weakened joint, with abnormal lateral mobility, will certainly eventuate. This result probably is not so liable to happen where the internal lateral ligament is the one affected, seeing that it is a broad structure, and therefore possesses more chance of uniting. It would seem almost certain to take place where the external lateral ligament has been torn, as this is narrow and cord-like, unless operation be carried out and the torn ligament sutured.

I have had several cases of recently ruptured internal lateral ligament in which abnormal lateral mobility was a prominent feature, but none in recent years. These cases were all treated by splinting over a prolonged period, but in no case was a really good result procured. If I were to meet another case I should unhesitatingly expose the injured ligament and bring together the torn edges with chromic catgut sutures.

The anterior ligament, or the ligamentum patellae, is sometimes torn. In a certain number of cases no doubt it has resulted in the same way as an ordinary transverse fracture of the patella, and in others it has occurred in consequence of sudden and forcible flexion of the knee joint.

Where such an accident has taken place, there is inability to extend the leg on the thigh, the patella is displaced upwards, and a gap is felt in the position of the patellar tendon. There may or may not be an effusion into the joint. The treatment to be recommended is, I think, primary suture of the torn ligament with chromic catgut or fine silk sutures, followed by rest in the fully extended position for at least eight weeks. At the end of this time splints may be discarded, but full flexion should not be allowed for a further two months. My colleague, Mr. Angus, has recently had two examples under his care. In both the cause was acute flexion, and in both primary suture with chromic catgut was used. In each case an excellent result was obtained.

To sum up the treatment, then, of recent rupture of these important ligaments, where forcible hyperextension has been the cause, I would recommend splinting in a slightly flexed position for twelve or more weeks, followed by massage and exercises. Where the internal lateral, external lateral, or anterior ligaments are torn, I think the best treatment is primary suture.

I have several times been consulted by patients who possess knees which are capable of being abnormally hyperextended, and which have resulted from severe injury some time previous. There is no difficulty, at any rate, in concluding that one of the crucial ligaments, or both, have been torn, but what ought to be recommended under these circumstances is a serious problem. My colleague, Mr. Rutherford Morison, has endeavoured to replace the damaged crucial by one of the semilunar cartilages, but with no success. Personally, in such cases I advise the patient to content himself with wearing a properly fitting knee brace.

The subject of haemophilia is a very interesting one, but may be dismissed in a few words. Children or young adults the subjects of haemophilia, on very slight injury to the knee develop haemorrhages of more or less amount in the articulation. In consequence swelling of the joint occurs. In the first attack or two the condition will probably readily be recovered from, and the parts may regain their normal condition. Subsequent attacks, however, result in degenerative changes taking place in the joint, leading to thickening of the synovial membrane and fibrillation of the articular cartilage. In consequence more or less permanent swelling of the parts remains, and ankylosis, more or less complete, is likely to result. Such cases may be mistaken for tuberculous or syphilitic disease, but consideration of the family and previous history will prevent error in diagnosis.

With regard to treatment, all that can be recommended is to warn a haemophilic patient to avoid injury as far as possible. If haemorrhage has already occurred into the knee, then rest in bed must be enjoined for a prolonged period, and ice applied to the injured part. Incisions and even explorations by a hypodermic needle must not be used.

Loose Bodies.

Some forms of loose bodies in the knee-joint undoubtedly result from accident or injury. During the past twelve years I find I have had a personal experience of 25 cases of loose bodies of all sorts. In some of these a history of definite injury was obtainable. In one case the body was found to be a small piece of articular cartilage; in another case it was found to be composed of fibrinated blood clot; while in 2 cases it was found to be composed of a portion of semilunar cartilage which had become detached in a way which I shall show you later, when I describe the different forms.

In 3 cases upon which I have operated on the assumption that they were suffering from torn semilunar cartilage, I found, on opening the joint, a remarkable condition of affairs. In the synovial fluid were a number of white flakes, their appearance suggesting thin slices of cartilage. For some reason or other no microscopical examination was made in the first two cases, but in the third—which only came under my care some days ago—I sent a flake to Professor Stuart McDonald. He reports definitely that it is fibro-cartilage, and therefore of the same structure as a semilunar cartilage. An interesting feature of the same case was that on the under surface of the semilunar cartilage a small thin shaving of its substance was stripped up. It was easy to imagine its complete detachment, becoming then one of the loose flakes before mentioned. In all three cases there had been repeated attacks of pain and swelling following upon a twist, and a prominent physical sign was marked crepitation on flexion and extension movements.

I have met with several cases where the loose body was composed of bone covered by articular cartilage, but as in these fracture of the subjacent condyle of the femur had occurred they would be beyond the scope of this discussion. The symptoms which arise from loose bodies in the knee-joint may at first be somewhat obscure, but later, as a rule, present no difficulty in diagnosis. They result from the body becoming engaged between the joint surfaces during the movement of extension. In this way the ligaments are stretched and perhaps even torn, thus giving rise to the pain complained of by the patient. A common history is that, while the patient is walking or running, he feels something slip in the knee, and a sudden pain is experienced in the joint, generally at the inner or outer side. He then finds that he is unable momentarily to fully extend his knee. In some cases the inability to completely extend the joint remains until the body is removed, but this can only happen when the body is large and wedged between the patella and the condyles. In at any rate the earlier attacks these symptoms are followed by an effusion into the knee-joint, which disappears in the course of a week or ten days. At first the patient is probably unable to feel the body, although at times he may be conscious of something moving about the articulation. Later there comes a time when he is able to feel it and perhaps demonstrate it to the surgeon. I have known sufferers from this condition, after the surgeon has persisted in a search lasting over several minutes, flex and extend the joint several times, simultaneously pressing with their thumbs round the patella, quickly locate the body, and fix it. These bodies are very elusive, and easily slip away into some inaccessible part of the articulation on the slightest pressure, and on this account the Germans have quite appropriately named them "joint-mice." A curious feature of the loose body is that on pressing it the patient complains of severe pain.

If loose bodies give rise to trouble the only treatment is removal. This must on no account be undertaken until they have been located and fixed in some accessible part of the joint. My own plan is not to use a general anaesthetic, as while the sufferer is being placed under its influence the body may slip away. After thorough cleansing of the skin surrounding the joint I fix the body by thrusting a hare-lip pin, or some such thing as a darning needle, through the skin into it, and next inject a few drops of weak eucaine solution in the line of the proposed incision. Then after opening the joint there is no difficulty in removing the troublesome agent. I need hardly say that strict aseptic precautions must be carried out previous to operation, otherwise a disaster may occur, as is shown in a case in which, a few years ago, I had to amputate the leg of a young man on account of acute septic arthritis of the knee-joint following upon the removal of a loose body by a doctor in his surgery, no aseptic or antiseptic precautions being used.

Injuries to Joints Affected with Osteo-arthritis.

Traumatic osteo-arthritis is looked upon by many surgeons as a definite pathological entity, but I am by no means convinced that such is the case, rather am I inclined to believe that such are cases where injury has aggravated a joint already affected with osteo-arthritis. I have, of course, encountered patients where, after a knee has been more or less severely twisted or contused, and particularly if these injuries have been frequent, signs of osteo-arthritis have been discovered; but in the large majority of such cases, on examining the opposite knee, signs of the same disease will probably be found, though generally much less marked.

One commonly meets patients who present definite signs of osteo-arthritis in their knees, signs such as crepitation on movement, lipping of bone, etc., and yet who complain of no symptoms and are able to work regularly and well. They then receive an injury, more or less severe, to one or other knee, and from that time complain of symptoms—such as stiffness, feeling of insecurity, and pain on walking or standing—for a long while. In many cases the injury is not a severe one, and would have been easily and quickly recovered from had the joint been healthy.

Changes in the knee-joint similar to those of osteo-arthritis are frequently met with in old people, and in all probability are of the same pathological nature. In these cases a comparatively slight injury has a similar effect as in the joints affected with osteo arthritis, and very often results in, especially where prolonged rest has been used, a painful and ankylosed articulation.

In these osteo-arthritic patients, after an injury such as a twist or wrench, symptoms similar to those of torn semilunar cartilage are complained of. Even at the time of the accident the patient may experience a click at the inner side of the joint, and inability to completely extend the articulation is also found. I have operated upon several such cases, and, beyond finding signs of osteo-arthritis, have never noticed tearing of the semilunar cartilages. In textbooks and elsewhere it is stated that the cause of the symptoms is probably nipping of a hypertrophied synovial fringe. Personally, however, I have not found this to be the case. Where I suspect that a joint is affected with osteo-arthritis I hesitate to advise operative interference, unless it be for the purpose of removing a loose body, such as might be formed of a piece of hypertrophied synovial fringe, portion of articular cartilage (which in this disease becomes very brittle), or an osteophytic outgrowth. The treatment I would recommend consists simply of rest to the injured joint until pain and tenderness have subsided; then carefully graduated passive and active movements are instituted together with hot douches and massage.

Injuries to joints affected with such a disease as tubercle, either latent or active, have also to be mentioned. In the former case the disease may become active again, but in any case treatment does not differ from that ordinarily used for tuberculous disease affecting a joint.

Injuries to Semilunar Cartilages.

I now come to probably the most interesting condition which will properly come within the scope of this discussion, namely, injuries to the semilunar cartilages.

In the Royal Victoria Infirmary, Newcastle-upon-Tyne, the hospital to which I am attached, these accidents are frequently met with. This institution receives patients from the whole of the northern counties, a district in which coal-mining forms one of the largest, if not the largest, industries. In these mines the seams of coal are, as a rule, low, and in very few instances exceed 4 ft. or 4 ft. 6 in. in thickness. The mine-worker, therefore—and this applies not only to the coal-hewer but to all underground workers—is seldom able, when once below bank, to adopt a position in which the knees are fully extended. In the great majority of cases they work in the squatting position or sit on a low stool. Their knees, therefore, are in a position in which a certain amount of lateral mobility and rotation is possible, a position which, I have before pointed out, conduces to rupture or tear of the semilunar cartilages.

I would here emphasize that in the large majority of cases definite splitting or tearing occurs, this being brought about, I think, by the inner circumference of the cartilage being nipped between the condyle of the femur and the tuberosity of the tibia, and then, in consequence of a sudden twist, being forcibly dragged towards the centre of the joint.

The internal semilunar cartilage is much more commonly torn than the external. I find that up to the end of March last I have operated upon 509 cases, of which only 38 have been external; this gives a percentage of 7.5. I think perhaps the reason for the greater frequency of internal semilunar cartilage tears or ruptures is to be found in the existing anatomical conditions. The external semilunar cartilage has a much looser connexion than the internal, consequently, supposing it became engaged between the external condyle and the upper surface of the external tuberosity of the tibia, and is then dragged towards the centre of the joint, stretching of its connexions rather than splitting of its own substance would be more likely to result. In the case of the internal semilunar cartilage, which has a close connexion with the internal lateral ligament and the capsule, a tear would be more likely to occur under the same circumstances. As a rule, the injury will be found in the anterior part of the semilunar cartilage, and therefore, on the joint being opened, is readily seen. Where it is in the posterior part, unless care be exercised, it may be easily overlooked.

Probably the commonest type of torn semilunar cartilage is that in which there is a split which extends for a variable distance from before back. This split varies in position, being sometimes quite close to the attached border, and in others near the free edge; but in all cases there still remains a portion of cartilage retaining its normal attachments (see Fig. 1). When the accident is recent the edges of the tear are rough, and may even be blood-stained. In old cases, on the other hand, the edges of the tear become rounded, and cicatrization may even be noticed at either end. The detached portion, on opening the joint, may still occupy its normal position, and unless careful scrutiny be made, may be overlooked. In the great majority of cases, however, it will be found displaced towards the centre of the joint, and under these circumstances is easily recognized, being practically only attached to its anterior and posterior ends (see Fig. 2). Where the split is situate in the posterior part it can only be demonstrated when the anterior part of the cartilage is divided and strongly dragged upon, and on this being done, the detached portion suddenly snaps forward.

In another type the tear extends from some point in the free edge across the cartilage, then forwards or more rarely backwards for a variable distance, thus giving rise to a pedunculated piece, which may readily become engaged between the condyle and the corresponding articular surface of the upper end of the tibia (see Figs. 3 A and 3 B). This pedunculated piece after a time, and in consequence of being frequently ground between the articular sufaces, becomes rounded and of a discoid shape (see Fig. 4). In some examples its attachment to the rest of the cartilage becomes very slender, and, no doubt in consequence of further trauma, it may become completely detached and form a variety of loose body (see Fig. 5). In others the loose piece—possessing quite a wide arc of movement, but still retaining an attachment to the cartilage from which it has been torn—slips out of the joint and can readily be felt in front of the condyle (see Fig. 6). I might add that it is only under these circumstances that, previous to operation, the torn piece can be seen or felt. In a case recently operated upon the transverse tear did not extend through the whole thickness, but only across the superficial fibres, which were also torn forwards for an inch, thus forming a pedunculated piece, which at times gave rise to trouble.

In a few specimens I have found that the under surface only has been split.

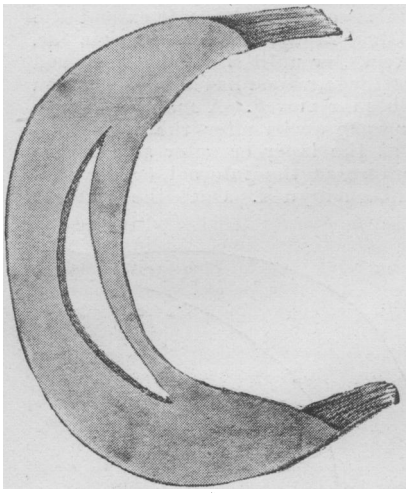

Fig. 1.

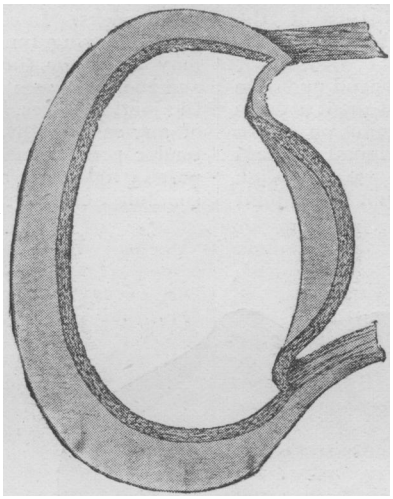

Fig. 2.

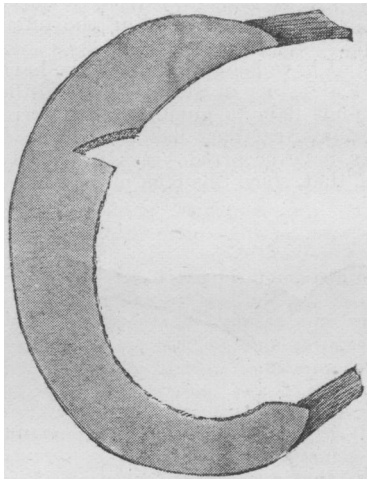

Fig. 3 A.

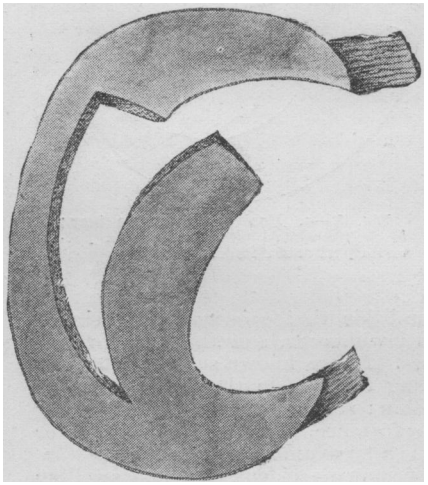

Fig. 3 B.

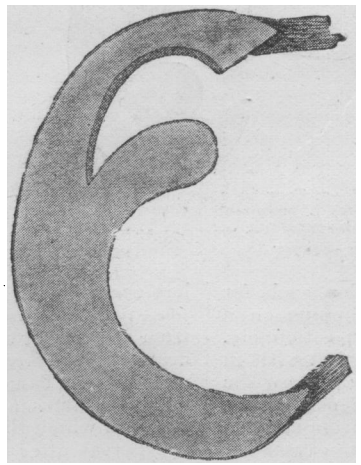

Fig. 4.

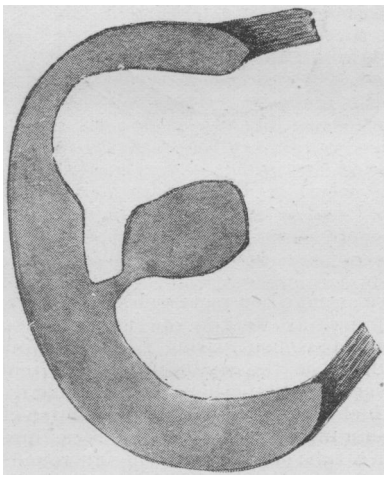

Fig. 5.

Definite injury, amounting to fracture of the articular cartilage, may be caused by sudden extension movement of the knee while the detached piece of semilunar cartilage is engaged between the joint surfaces.

A short time ago I operated upon a man who, eighteen months previously, had severely twisted his right knee in consequence of his right foot slipping on a banana skin. At the time of the primary accident he experienced very severe pain at the inner side of the joint and also felt something crack in the same situation. He fell to the ground, and on rising his knee was locked, and could not be extended beyond semiflexion. He hobbled home, and shortly afterwards was seen by a bonesetter, who made forcible attempts at extension, and in the end seems to have succeeded, as after the efforts this movement could be effected, and he was able to walk about much more comfortably. Since this time he has had several attacks of pain of much the same character as the first, only much less

severe. A week previous to being seen by myself he twisted the same knee while getting out of bed. The same signs and symptoms resulted, and, previous to operation, he was still unable to completely extend the joint. I found, on opening the articulation, that the internal semilunar cartilage had been torn across about its middle, then split forwards, the loose portion lying in the joint. On the under surface of the internal condyle towards the intercondyloid fossa, and with its attached edge towards this fossa, was a semilunar tear in the articular cartilage. This included a piece of cartilage which could easily be lifted forwards, and had no doubt been caused by the torn piece of semilunar cartilage becoming interposed between the articular surfaces of the internal condyle and internal tuberosity of the tibia, and then sudden extension taking place (see Fig. 7). In another case the torn piece of an internal semilunar cartilage caused splitting of the articular cartilage covering the internal tuberosity of the tibia.

As I have before indicated, we have to depend upon the patient's story of the accident and the subsequent attacks of joint pain to guide us to a correct conclusion that a semilunar cartilage has been torn. The original accident may have occurred years previously, and we are often told that, since this took place, attacks of pain in the joint have occurred on more or less slight provocation, such, for instance, as walking on uneven ground, slipping on a greasy pavement, rising from the squatting position, etc. Seeing that the condition is most frequently met with in miners, it will perhaps be advisable if I indicate how the accident often occurs in the course of their occupation. A man in a squatting position is casting coals from one side into a tub; the body swinging round too far causes the knee to be forcibly twisted inwards or outwards. Again, while hewing in the squatting position the same thing may occur; or, again, while walking in the stooping position with the knees flexed he may get his foot fixed in a hole, the corresponding knee becoming twisted and the cartilage torn.

Football players are, next to coal-miners, the most frequent sufferers from torn semilunar cartilage, and the accident is brought about, very often, in the action of swerving or dodging. Here, one foot being firmly fixed in the ground, in consequence no doubt of the long studs in the player's boot, and the body momentum going on, the knee on the same side becomes violently twisted. Again, in some cases, where the ball is about to be kicked, say with the right foot, but instead is missed or miskicked, the left foot being fixed in the ground and the body momentum swinging round, the same knee may become twisted and the cartilage torn. I would here mention that I have never known the accident result in consequence of a direct blow.

However the accident happens, the first symptom is very severe pain, which is often primarily felt over the whole joint. Later it becomes localized to a point at the inner or outer side, according as the inner or outer cartilage is injured, and may be so excruciating as to cause faintness and vomiting. Simultaneously, a click or a snap is felt in the same situation, and, as a rule, the patient falls to the ground. In the majority of cases, the joint is incapable of full extension, and feels absolutely helpless. One is frequently told that it is only after the joint has been flexed and extended several times, probably by a fellow-worker, that the movement of full extension is restored. When this takes place, the pain is very much lessened, and, in many cases, the patient is then able to hobble home. In a few hours marked swelling of the joint occurs, the result of effusion into it, and this, in consequence of treatment, disappears in the course of two or three weeks. In certain cases the inability to extend the joint following immediately on the accident persists for, may be, two or three weeks, or until the joint is opened and the torn piece of cartilage, which has slipped between the joint surfaces, has been removed. A marked feature of any case is that for some weeks after the accident a tender point remains at the inner or outer side of the patella ligament, according as the internal or external semilunar cartilage has been injured. Once the accident has occurred, it is probable that subsequent attacks of joint pain and disability will occur, and these may result from very slight causes. I have known such an attack be brought on by catching the toes in the bed clothes or slipping on a banana skin; moreover, it may occur at very awkward times, as, for instance, while crossing a road or street in which there is a large amount of traffic.

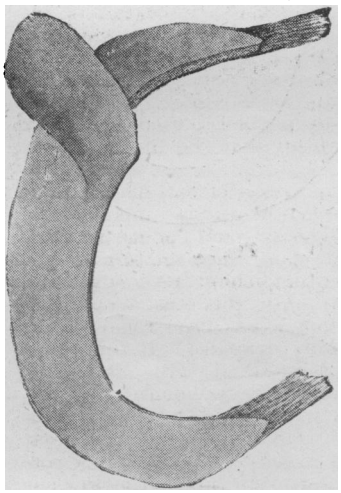

Fig. 6.

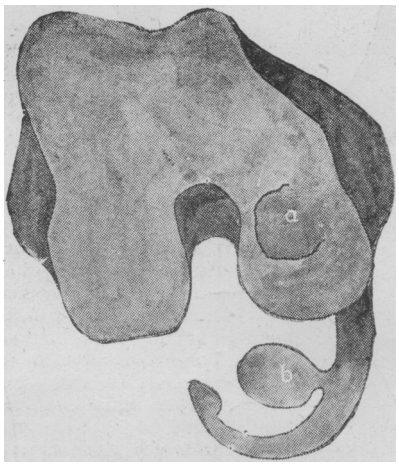

Fig. 7.—*a*, Tear in articular cartilage caused by a pedunculated piece, *b*, of internal semilunar cartilage torn from anterior portion.

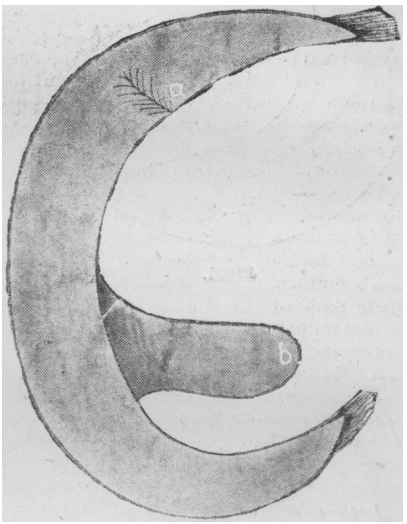

Fig. 8.—*a*, Healed transverse tear; *b*, pedunculated piece torn from posterior part of cartilage.

Whereas after the primary accident pain and swelling are very prominent features, in subsequent attacks these often become much less marked. Frequently an attack will consist of little more than experiencing pain at the inner side of the knee, and a click or snap in the same situation. The joint is then found to be locked in a more or less flexed position, and remains so until, while the knee is being moved, another click or snap is experienced, and it is found that full extension is possible. These attacks occur more or less frequently, and, where they have been often experienced—owing, no doubt, to increased tolerance—may be followed by no effusion in the articulation, but invariably on examination a tender spot will be found at the inner side of the patella tendon.

When a clear history, such as I have described, is obtainable, there will be no difficulty in coming to the conclusion that a torn semilunar cartilage is the cause of the symptoms. In some cases of loose body, however, especially just after the first attack of joint pain, there may be some difficulty in coming to a correct diagnosis; but in these, unless the body be of large size and wedged between the condyles and the patella, the locking is only

momentary. Again, in almost every case of loose body there comes a time when it can be actually felt, and in these circumstances no mistake can be made. Perhaps the condition for which a torn semilunar cartilage is most frequently mistaken is osteo-arthritis. Patients suffering from this disease, after twisting a knee, may complain of pain which was previously not noticed, or at least was not a marked feature, and the pain is often referred to the inner side of the joint, just in the position where it is present in the case of a true tear of the semilunar cartilage. Moreover, inability to extend the joint may be a prominent feature, and a tender point at the inner side of the joint is frequently demonstrable. As a rule, however, it is comparatively easy to distinguish between the two, if sufficient care be taken. In the case of the osteo-arthritis, the patient is beyond middle life, there is crepitation on moving the joint, and there may be actual lipping of the articular ends of the bones. Again, the other knee may present definite evidences of the disease.

Treatment.

With regard to the treatment of torn semilunar cartilage, the question arises as to whether in a recent case healing may take place with appropriate measures. That cicatrization may and does take place is shown in several specimens which I have removed, and in which scar tissue has been seen at either end of the split. In one, where a complete transverse tear had occurred, complete healing has actually taken place. This last specimen I can show you, and a curious feature about it is that in its posterior part a second tear has taken place, the detached portion being rounded and somewhat discoid in shape (see Fig. 8). Complete healing, of course, can only take place in a recent case if the edges of the tear are kept in accurate apposition over a long period; and, inasmuch as it is impossible to be certain that apposition in a given patient has been secured, a good result will be problematical and impossible to foretell. However, if your patient be in easy circumstances it is certainly worth while, after getting rid of the effusion, to thoroughly immobilize the articulation in a plaster-of-Paris splint, extending from the toes to the upper part of the thigh. After this has been in position for two months it may be removed and cautious movements commenced.

In the case of patients who do not need to earn their living by hard manual work, and who are content to give up such strenuous games as football, hockey and cricket, or who are unwilling to undergo operative measures, treatment such as I have just recommended is also indicated.

Where a tear has resulted sometime previously there will probably have been more or less numerous attacks of joint pain, and we may safely assume that in each attack the damage to the torn cartilage has increased. Under these circumstances I am sure no good purpose is secured by prolonged rest, and the best treatment then in patients who refuse operation is, after getting rid of all swelling and pain, to prevent rotatory movements by wearing a well-fitting knee brace. Such a brace, to be effective, is necessarily somewhat cumbersome and clumsy, but with it, providing he is content to give up violent forms of exercise, subsequent attacks may be completely prevented.

Where the patient is engaged in manual labour, and a perfectly sound joint is consequently necessary, operative treatment must be recommended—of course, in the absence of intercurrent disease. This treatment ought also to be recommended in the case of a man or woman who is desirous of still taking part in open-air sports, such as football, cricket, hockey, riding, etc. Again, where inability to fully extend the knee persists, the same treatment must be carried out.

The question now arises as to the time when one should operate. Personally, I always wait a week or ten days after an attack. I do this because by that time the devitalizing effect of the injury shall have passed off. Previous to and during operation, the most rigid antiseptic precautions are necessary, and, for my own part, I do not use dry sterilization, but rely mostly on chemical methods. If possible, I keep the patient in bed for thirty-six hours previously, and at the beginning of this period commence preparations. The whole of the skin of the leg and thigh is shaved, thoroughly washed with spirit-soap and hot water, then with turpentine, and finally with methylated spirit. It is then thoroughly rubbed over with swabs of cotton-wool wrung out of 1 in 1,000 corrosive sublimate solution, and finally is covered with a compress wrung out in the same solution, extending from the middle of the thigh to the middle of the leg; this compress is covered by mackintosh and secured by a bandage. Twenty-four hours later the thigh and leg are again washed with the 1 in 1,000 corrosive solution and a compress wrung out in the same solution reapplied. When the patient is anaesthetized a tourniquet is applied round the thigh, and, after the compress is removed, the operation area is thoroughly washed with a solution of 1 in 20 carbolic acid; the knee is then thoroughly flexed and kept in this position by my assistant, who stands opposite to me.

I use a transverse incision, commencing, in the case of the internal cartilage, at the inner border of the patella tendon and extending backwards for a distance of about 2 in. in the line of the articulation. I am firmly convinced that this incision gives the best exposure, and, if the internal lateral ligament be not cut across, the after-stability of the joint is not interfered with. Some years ago, in the practice of another surgeon where this precaution was not observed, a somewhat unstable joint resulted, in which there was a certain amount of abnormal lateral mobility.

On dividing the skin and subcutaneous tissue a strong aponeurosis is exposed, which is also divided in the length of the incision; then the capsule and subjacent synovial membrane is opened and the interior of the joint exposed.

If the split or tear be situate in the anterior part of the semilunar cartilage it will be quickly recognized, particularly if the torn portion be displaced towards the centre of the joint. In a few cases, and even where the tear has been fairly extensive at the time, on the joint being opened the parts seem in their normal condition, and it is only on careful scrutiny that the line of tear is discovered.

Where the damage is in the posterior part of the cartilage, in a large number of cases it will be impossible to demonstrate it until the anterior extremity of the cartilage is divided and strongly pulled upon, when the torn portion will suddenly snap forwards from behind the condyle, and it will then be found that, until this has again been reduced into its normal position or has been removed, the joint is incapable of being fully extended. If this snapping forwards be once witnessed, it will readily be appreciated that at the time of the accident an audible snap or click will occur, and it will also explain the subsequent signs and symptoms. On three occasions at least I have had to open the joint a second time, where a posterior split existed and had been overlooked at the previous operation. If the anterior extremity of the cartilage had been divided and strongly pulled upon, this mishap would not have occurred. Personally I aim at removing the entire cartilage, and in the large majority of cases this is quite an easy procedure. After the cartilage is removed the capsule and synovial membrane are sutured in one layer with thin catgut; the incision in the aponeurosis is similarly dealt with, and the edges of the skin are brought together with a subcuticular suture. An antiseptic dressing, consisting of gauze wrung out of a solution of corrosive sublimate in methylated spirit (1 in 1,000) is then applied, and over this a thick layer of wood-wool wadding, both being kept in place by a domette bandage. I use no splint in the after-treatment, and encourage the patient to move his knee, as far as the dressing will allow him, as soon and as freely as he can. During the operation neither my assistant's nor my own fingers come in contact with the wound, all manipulations being carried out with instruments, and, needless to say, india-rubber gloves are worn by operator, assistant, and nurse.

After the operation, for the first two nights, a rise in temperature, to the extent of 1° or even 2°, need cause no alarm, and during the same period severe pain may be experienced, sufficiently bad to necessitate one or two hypodermic injections of morphine. Beyond this the convalescence of the patient is quite straightforward, and at the end of a week the dressing is taken down, and the subcuticular suture is removed. There is no difficulty with after-stiffness, and even at the end of ten days the majority of the patients are able to fully flex the knee and to commence to walk about without any support.

The operation is a very successful one, and it is

extremely rare for patients to be otherwise than completely relieved by it.

In several cases I have removed both internal semilunar cartilages with an interval varying from six weeks to five and a half years between the two operations. In one case both internal cartilages were removed at the same operation; in a further case both cartilages, in the same knee, were removed at the same operation, and in three cases both cartilages in one knee were removed in two operations with an interval varying from eight months to three years between the two operations. All these patients did well.

In conclusion, I would state that for a long time the question of injuries to the semilunar cartilages has not received the recognition it deserved, and it is only in the past few years that these injuries have commenced to be really understood. This injury, which is so common in such an important industry as coal-mining, which undoubtedly causes a large amount of unemployment, and, therefore, results in the loss of a great amount of money, surely should have commanded more attention.

II.—ALBERT J. WALTON, B.Sc., M.S., F.R.C.S.,
Assistant Surgeon, Dreadnought Hospital, Greenwich.

IN a previous communication[1] I attempted to show that injuries of the semilunar cartilages were brought about by a condition of hyperextension of the knee, and not, as is usually taught, by a rotatory movement while the knee is in a position of semiflexion. The proof of this argument was based upon the study of the anatomy and the movements of the joint.

Time will not permit me to-day to enter as fully into this aspect as I should have desired, and therefore I must refer to this previous paper for a full account of these points. I shall, however, again consider the condition from two aspects. First, the anatomical; and, secondly, the clinical.

Anatomy.

Examination of the dissected knee-joint shows that during extension both lateral ligaments, the posterior ligament, and the two crucial ligaments are tightened. Of these latter it is usually taught that the posterior is loose during extension; this is, however, not the case. Its upper extremity is attached behind the mean centre of rotation of the articular surface of the femur, as is well shown in the diagram (Fig. 1), and must, therefore, be tightened during extension. In other words, during extension the tibia will approximate to the femur

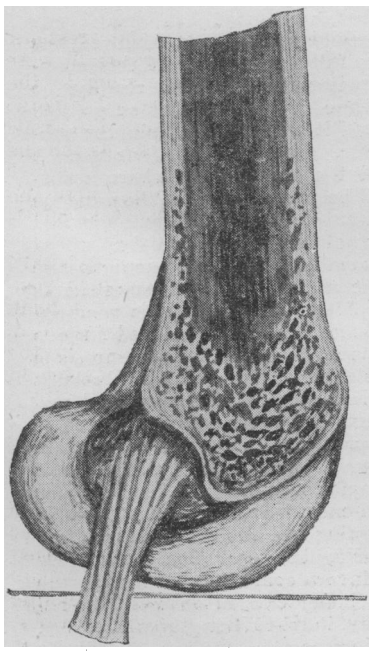

Fig. 1.—Attachment of posterior crucial ligament to outer surface of internal condyle.

At the termination of the movement of extension, the tibia will rotate outwardly on the femur. This is due to the pull of the two crucial ligaments, which, being attached to the internal and external condyles of the femur respectively, will act as a "couple" as represented in the figure (Fig. 2). That this is so is well shown by the dissected joint which I present. It is in no way dependent upon the shape of the articular surface.

This screw action is simply a continuation of and part of the movement of extension.

The internal semilunar cartilage is loosely attached anteriorly. Laterally it is firmly attached to the internal lateral ligament, and behind this it is protected by the semimembranosus muscle.

On section it is "wedge"-shaped, the wedge fitting between the articular surface of the two bones. It is a very elastic substance, its two ends tending to approximate; this being well shown in a freshly removed cartilage.

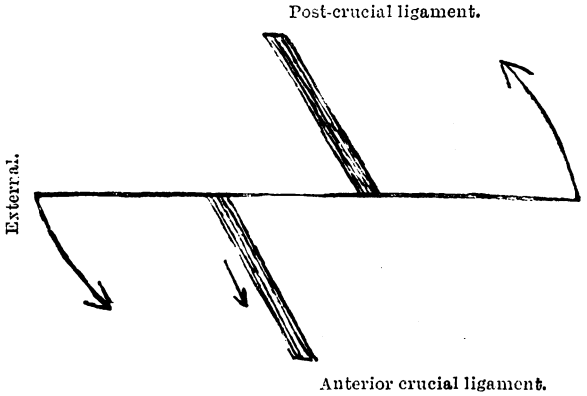

Fig. 2.—Action of the crucial ligaments in causing internal rotation of the femur at the end of extension.

There is therefore always a tendency for the ends to pass into the interior of the joint, and since the anterior end is markedly the thinner of the two, this tendency is also more definite anteriorly. On extension of the joint, therefore, the tibia and the femur will be forcibly pulled together. This force, owing to the screw action, will be almost wholly exerted on the inner side and anteriorly. The following conditions may then take place:

1. The anterior end of the cartilage, having passed somewhat into the interior of the joint by its own elasticity, may be caught during a sudden movement of extension between the approximating bones and forcibly crushed, fracture of the cartilage thus taking place (Fig. 3).

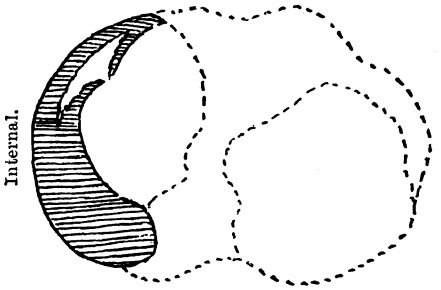

Fig. 3.—Cartilage crushed by pressure between femur and tibia.

2. The wedge-shaped cartilage may be forcibly squeezed out from between the bones and torn from its attachments. This will either take place anteriorly or at the junction of the fixed and movable parts—that is, just in front of the internal lateral ligament (Fig. 4).

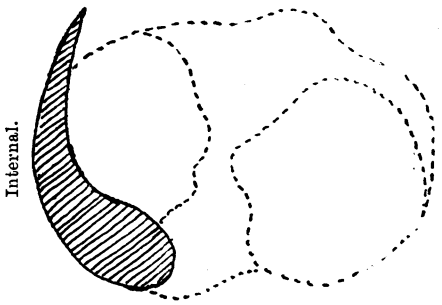

Fig. 4.—Separation of anterior attachments of cartilage by forcible extension.

3. It may have passed sufficiently far into the joint to be caught on the outer side of the internal condyle of the femur. On extension it will then be pushed into the intercondylar space (see Fig. 5).

4. After its attachment has been torn by the first movement of extension of the knee, it may, on flexion of the

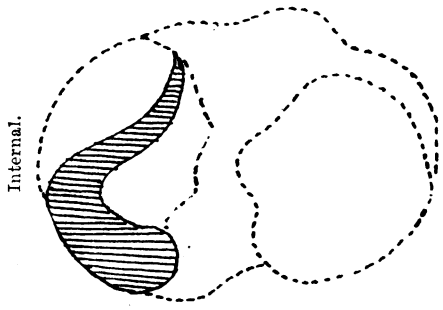

Fig. 5.—Position of separated cartilage on full extension. Second step.

joint, pass between the two bones and be crushed on the second movement of extension, a secondary fracture of the cartilage thereby arising (Fig. 6).

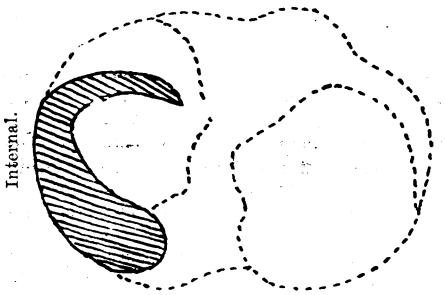

Fig. 6.—Separated anterior end of cartilage lying between femur and tibia on full flexion.

It will be readily noted that when the cartilage is thus crushed it prevents approximation of the two bones, giving rise to what is clinically recognized as locking of the joint.

All these conditions, which are identical with those found clinically, can be easily reproduced in anatomical specimens, but there is no evidence from such anatomical specimens that any lesion of the cartilage can occur while the joint is in a position of flexion or semiflexion.

As has already been shown, the pressure between the two bones is, owing to the screw action, most marked on the inner side. In fact, lesions of the external cartilage cannot readily be caused.

Clinical Aspects.

It has been shown beyond question that lesions of the internal cartilage are much more common than those of the external.

In the series of cases I have already reported from the London Hospital, 73 out of 77 were internal. Since then I have operated on a further 8 cases, in all of which the internal cartilage was alone affected.

It is also equally agreed that the anterior part of the cartilage is much more commonly affected than the posterior part. In the above series of cases the site was noted in 76. The anterior end of the cartilage was alone affected in 70 cases.

It was previously thought that either separation or transverse fracture was the common lesion. Rutherford Morison showed, however, that a longitudinal fracture was much more frequent as a primary lesion, although such a condition is liable to be overlooked, unless carefully looked for.

The more recent cases of this series have fully borne out this contention—7 of the 8 recent cases mentioned above showing this change.

More rarely transverse fracture or separation of the anterior extremity takes place. In 5 cases the cartilage remained attached at its extremities, but was separated at its circumference.

The nature of this lesion is readily accounted for if one believes that the cartilage passes sufficiently far into the interior of the joint to be caught by the apex of the wedge of the internal condyle of the femur during extension.

The clinical condition therefore agrees absolutely with that which can be artificially produced.

All investigators, however, are agreed as to the lesion being caused with the knee in a position of semiflexion. I have shown that in cases met with in a general surgical practice the history, if carefully inquired into, will show that the knee was really hyperextended at the time of the accident, but owing to the sudden pain the joint is immediately flexed, the patient falls, the cartilage passes into the joint, the knee is locked, and the patient on attempting to rise finds that the knee is fixed in the flexed or semiflexed position, hence giving rise to the belief that the accident took place when the joint was so flexed.

In the majority of the cases I have previously reported such a history of extension was clear, and in the further 8 cases it was also beyond question.

At the time of my last report my views were severely criticized in as far as they applied to miners. I have no experience with this class of patient, but Mr. Finch has since shown very clearly that the same factor of hyperextension is true for them also. I shall therefore leave him to deal with this aspect of the question and to overcome the only definite objection to my views.

As regards the other types of cases, 30 were caused at football. Of these, 3 kicked at the ball and missed it; 4 were passing the ball from the wing to the centre, or vice versa, the ball being hit by the inner side of the foot whilst the leg was extended.

In 21 the foot was everted during running, the front part of the foot of necessity coming into contact with the ground whilst the leg was extended. In the remaining 2 a second player fell across the patient's outstretched leg.

In a further 22 cases the patient was walking or running over rough ground. Here, as in the larger group of footballers, careful questioning elicited the fact that the foot was everted as it first came on to the ground, and that at this stage the knee was completely extended.

A careful consideration of the mechanism of these movements will show that this must indeed be the case.

In 11 the patient fell from a height; in 3 he was stepping from the train to the platform, the position of extension being again clear.

The lesion is not uncommon among boxers and wrestlers, but in this series there were only 3 such cases; 2 were boxers, and both gave a clear history of rotating to the right and drawing the body backwards to avoid a blow, whilst the left leg was extended and in advance, the screw action of hyperextension on the left leg, which was the one affected, being self-evident.

In 4 cases the condition arose whilst jumping; here the forcible extension at the moment of the take-off is evident.

Of the 3 further cases, 1 occurred while throwing a ball; one while the patient was rising from the stooping position; and the third from being thrown out of a bunk whilst the foot was caught, the leg being hyperextended, and the femur rotated inwardly on the tibia. In the remaining 8 cases no history of the accident was given in the notes.

It is important to note that nearly every case that I have examined myself gave at first a history of having twisted the knee while it was semiflexed, but when an exact description of the accident was asked for, not only was hyperextension at the moment of the injury made clear, but the patient corrected himself and stated that the leg was either straight or being forcibly straightened when the accident occurred.

Such a history is in my experience constant and definite, although every care is taken not to put leading questions, and as far as possible not to suggest to the patient what answer is required.

I venture to think, therefore, that our views as to the causation of this lesion must undergo revision, and all the evidence at our command, both anatomical and surgical, is in favour of it being caused by hyperextension with its terminal movement of external rotation of the tibia.

REFERENCE.

[1] *Proc. Roy. Soc. Med.*, November, 1912.

DISCUSSION.

Mr. R. H. ANGLIN WHITELOCKE (Oxford) thanked Mr. Martin for his thorough and complete survey of the subject. He was in so much agreement with him as to the etiology

and in a measure with his treatment, that he would but refer to a few of the points to which Mr. Martin had not referred specially. As regards anatomy, he believed that the integrity or otherwise of the internal lateral and crucial ligaments was the important one in the etiology of most of these ailments. When either or all of these ligaments were torn, the joint became weakened and liable to injury as increased external rotation was permitted. Sprains should never be regarded as simple where there was much effusion, especially if this followed immediately, the effusion in these cases being of blood and indicative of considerable amount of tearing of ligaments or periosteum, or even detachment of bone. One should never be satisfied in such a condition until fracture had been excluded by a radiograph. Simple sprain was treated by elastic pressure, and rupture of ligaments by open operation and suture. As regards haemophilia, he mentioned a case where, in mistake, he opened a knee to remove a torn cartilage, and found the patient a haemophilic. For days he bled, and the only means which succeeded eventually in stopping the bleeding was by using horse serum by injection; two injections were enough. One form of loose body that he would specially like to call attention to was the variety which was usually single, and often described in textbooks as concavo-convex in shape. These were the result of separation of a portion of an articular cartilage, sometimes the result of strain, at others from a direct blow. These loose bodies continued to grow for years, although completely detached and floating in the cavity, and should be always removed. He possessed a specimen of which he had a history of increase in size for over twenty years. He believed in the case of damage to semilunar cartilages that the injury occurred when the joint was in slight flexion with outward rotation, and not in extension, as exemplified by its frequent occurrence in football players and miners. His experience was with athletes mainly, and he believed that in them the injury was mainly and primarily a transverse fracture, becoming later a longitudinal one, and not longitudinal splitting, as is mainly found in quarrymen and miners. Partial avulsion of the tubercle of the tibia was common in athletic boys from 14 to 16. The pathology was, in addition to the bony separation, a tearing of the periosteum in the neighbourhood, and a haemorrhage into the infrapatellar bursa. The injury resulted always in cure in from two to three years, though with permanent thickening of the tubercle, but complete restoration of function. An operation might be performed to deal with the condition if the friends should so desire, but it was, however, never necessary.

Mr. E. W. HEY GROVES (Bristol) expressed the opinion that neither flexion nor extension was the real anatomical position, but that it was violent rotation which tore the cartilage. It was as difficult to make an accurate diagnosis of internal derangement of the knee-joint as of internal derangement of the abdomen. They settled the difficulty by opening the abdomen, and in the same way they must decide that the best way to settle their difficulties of the knee-joint was to open the joint. Better results would be obtained by free radical exposure of the joint by a transverse incision carried through the patella.

Dr. T. KENNEDY DALZIEL (Glasgow) pointed out that in addition to the injuries described by Mr. Martin they occasionally found a condition which might be described as pulverization of cartilage. Direct violence through the one bone acting on the other forced the cartilage from the bone. Such fragments probably accounted for some of the fine foreign bodies which might be found in the joint. These denuded areas of bone healed, and an irregular scar would mark the site.

Mr. ERNEST FINCH (Sheffield) said: Early this year I investigated 102 cases of internal derangement of the knee-joint treated at the Royal Infirmary, Sheffield, in the five years 1907–11. I was only able to examine 60 of these cases, so any figures I may quote will be confined to these, which I have personally examined. The investigation was undertaken in order to ascertain (1) the wage-earning capacity after operation, (2) the length of time off work before and after operation, and (3) the type of accident which caused the injury complained of. A clear conception of the anatomy of the knee-joint is essential for diagnosis and treatment. Especially would I lay stress on the external rotation of the tibia at the completion of extension, also the relation of the internal semilunar cartilage to the internal lateral ligament of the joint. The internal lateral, the anterior crucial, and post-crucial ligaments are all tense at the completion of extension. The symptoms are those usually described in the textbooks. The history of the patient is often the main means of diagnosis. There is one sign on which I would lay stress, and that is the presence of a spot of exquisite tenderness, on the anterior and inner aspect of the joint over the anterior horn of the internal cartilage, when this is the cartilage injured. This sign can be elicited often months after the accident. In regard to diagnosis there are three important conditions to differentiate; (1) Synovial fringes; (2) osteo-arthritis; (3) early chronic infective arthritis. In regard to treatment, if seen immediately, reduce, cold application, rest, and retentive apparatus; if seen after the patient has had the further trouble of recurrence, then operate. The two points of importance are: (1) Asepsis; (2) remove the whole cartilage; no resection, no stitching in position should be done. After treatment I advocate: (1) No drainage to the joint; (2) movement after seven days, active by the patient at first, passive movement at the end of fourteen days if the wound is quite healed; (3) no retentive apparatus to be allowed whatever; (4) discharge from hospital three weeks after operation, and start work six weeks after operation. Of the cases examined by myself after operation, 60 in number, the following are the chief points. Sex: 59 males and 1 female. Age: youngest 11 years of age, operated upon at 24 years; 1 case also received the injury at 12 years, and was operated on at 29. Both injured at football, and both have played since the operation. *Occupation.*—Miners injured during occupation 25 in number. *History.*—Position of the joint: Sudden extension from a position of partial flexion in 34 cases, flexion in 11 cases, uncertain in 14 cases. I asked every patient to get into the position he occupied at the time of the accident, and I satisfied myself that sudden extension from a position of partial flexion accounted for the majority of the "uncertain" cases. The football injuries were definite and were 5 in number. Four were in the act of kicking when knocked over, and on reaching the ground the joint was fixed. The other patient was running when he was tripped, and the joint was fixed almost immediately. That the suddenly extended position causes accident has recently been borne out by a medical colleague while keeping goal at football. *Time in Hospital.*—Average of 60 cases is 22 days, shortest time 12 days, longest time 37 days. *Back to Work.*—The average of 60 cases is 7 weeks after operation, the shortest time was 16 days. Five cases have not returned to work. Since these cases were seen one of them who had not worked for six years, having injured himself in 1907, when the cartilage was stitched, has now gone back to work, the cartilage having been removed in April of this year. The reason he gave for inability to work during the past six years was that the joint was often locked. In one other case there was marked ankylosis. In the other three cases I could find no cause for non-return to work. A few of the other noteworthy cases are:

J. B.—Left internal cartilage removed 1906; right internal cartilage removed 1909. Both injured at football. He still plays football.

W. P.—Both internal and external cartilage removed. He is now working.

B. C.—Injured twenty-five years ago; then operated upon with bad result. Re-operated, 1909. Wage-earning capacity now the same.

The cartilage was stitched in three cases, one with good result. Two still have locking. One of these since operated on, and now has a perfect result. *Patients' Opinions:* Forty cases were pleased with the result; nine cases fairly successful; eleven cases not satisfied at all. Creaking in the joint I do not think of importance; many of the cases who were back at their own work had it well marked. Only those cases who had not worked had wasting.

Mr. COTTERILL (Edinburgh) remarked that he took a special interest in the subject of derangement of the knee-joint, as it was just forty years since he assisted the

late Professor Annandale in all his pioneer operations in this department of surgery. He disputed several points brought forward by previous speakers. (1) It had been said that the whole thickness of the cartilage was never turned in. That had not been Mr. Cotterill's experience, and he had operated on many cases where the whole thickness of the anterior end of this cartilage had been separated from its attachment and turned in. (2) He was strongly of opinion that the best incision was a longitudinal one, and when it was necessary to examine the whole joint this vertical incision could be produced, the tubercle of the tibia chipped off, the patella externally dislocated, and the joint widely exposed. The tubercle was replaced and fixed in its old position by a nail. (3) It was very rarely necessary to excise the whole cartilage. It was sufficient to remove the part projecting into the joint. (4) The lesion *never* took place in full extension (as stated by Mr. Walton), as then the cartilage was tightly "splinted" between the bones. It occurred *in process of extension* from the flexed position, when the tibia was externally rotated on the femur, a grinding action being thus brought about. (5) It was advisable to operate in certain cases, as there was a tendency to osteo-arthritis, etc., being caused in chronic cases. Forcible hyperextension was of value as a means of certain identification of any substance, displaced cartilage, loose body, etc., lying in an abnormal position between the joint surfaces.

Mr. McADAM ECCLES (London) said: The partial separation of the tubercle of the tibia in an adolescent is by no means uncommon, and, as Mr. Whitelocke has said, may lead to prolonged convalescence. In some cases this continuance of discomfort and inability to carry out athletics is due not so much to the tubercle but to an ossification in the patella tendon, easily shown by a skiagram. This formation of bone is in its nature similar to traumatic myositis ossificans. The small mass of bone may be quite separate from the tubercle, but its presence appears to cause the persistence of the bursitis. I have operated upon several of these cases by longitudinally splitting the patella ligament fibres, removing the mass of bone and the inflamed post-ligamental bursa.

Mr. CHAD WOODWARD (London) said: I entirely agree with Mr. Martin's remarks about the undesirability of using a general anaesthetic in the ordinary cases of solitary loose body in the knee-joint. With the aid of a few cubic centigrams of a 1 per cent. solution of novocain the body can be harpooned and then removed through a tiny incision. Patients after this little operation walk about in eight or ten days. The term "Schlatter's disease" includes, in my opinion, several distinct pathological entities. There is one variety which was well described years ago by Sir James Paget. It is of the nature of a chronic traumatic periostitis and osteitis around the tubercle of the tibia and anterior aspect of inner tuberosity. In several such cases under my observation the patients were of what one can only describe as the loose-jointed type of person, and the ligamentum patellae was unusually long. The disability may persist for years, but they all recover when complete ossification takes place and the tubercle becomes joined up to the tibia. But many prefer a more speedy cure. They do well after operation. Most previous speakers have largely confined themselves to discussing the cases requiring operative interference. I should like to draw attention to some points in the treatment of those cases of sprain which form the vast bulk of all knee-joint cases and which, if properly dealt with, seldom need operation. The first indication is to empty the joint of fluid. In slight cases this is readily accomplished in a few days by daily rubbing and the application of firm elastic pressure. In severe cases the joint should most certainly in the first place be emptied by aspiration. The most striking feature in these cases, when seen some weeks after the injury, is the extreme degree of muscular wasting, frequently amounting to as much as an inch and a half of difference in the measurements of the two thighs. This is chiefly due to the antiquated notion of the necessity for rest in these cases. As soon as the fluid has been removed exercises should be systematically undertaken together with massage. In a week or two the knee is firmly strapped and the patient allowed to go about as usual.

The President, Mr. THELWALL THOMAS, preferred an oblique incision, and did not think it necessary to remove the whole of the semilunar cartilage, and thought from his experience that the injury was caused during flexion.

Mr. A. M. MARTIN, in reply, regretted that he had not dealt with fracture of the tibial spine, as he had thought that injury outside the scope of the discussion. He agreed as to the necessity for an *x*-ray photograph in injuries of the knee-joint. On the anatomical point raised by Mr. Walton, he was perfectly convinced that it was absolutely impossible for such an injury to take place in the extended position. Miners worked entirely in such a posture that the knees must be flexed, and it was while in this position that the injury occurred. In football players the non-kicking leg was the one affected. He thought that the presence of a point of tenderness insisted upon by some speakers was of no great moment; the same sign was present in osteo-arthritis. After operation for torn semilunar cartilage the time spent in hospital was no more than eight to ten days. No splint was employed. Active movement was permitted as soon as the patient felt inclined. Active movement was more reliable than passive movement. He most cordially thanked the members of the Section for their kind attention.

ON THE TREATMENT OF COMPOUND AND COMMINUTED FRACTURES.*

By ERNEST W. HEY GROVES, F.R.C.S.,
Bristol.

IT is rather remarkable that in the enthusiasm which has been displayed during late years concerning the operative treatment of fractures there has been so little said or done on the subject of compound or severely comminuted cases.

The two chief protagonists of the operative treatment of fractures—namely, Lane and Lambotte—lay great stress on the inadvisability of applying their methods to any case that is complicated by an open wound. And these methods are so difficult of execution even in simple cases that they become for the average surgeon quite impossible if they have to be applied to the union of many small fragments. Now, it is a matter on which great difference of opinion still exists as to the advisability of operation upon cases of simple fracture. Great authorities, such as Bardenheuer and Lucas-Championnière, consider that as good or better results can be obtained by simple extension with massage and early movements, but all are agreed that the compound fracture with much displacement and the severely comminuted fracture gave bad results by all methods of treatment; and yet these very classes of case have been withheld from the scope of the usually described operative methods. For the last three years I have been trying to solve this problem, working on experimental lines first, and then adapting my conclusions to clinical work. First let me summarize the difficulties that have to be overcome:

1. *Mechanical Difficulty of Fixing Small Fragments.*—Supposing the shaft of the bone to be broken into a number of small fragments, it is very difficult by any system of plates and screws to restore a firm continuity to the shaft of the bone. This is a difficulty when experimenting with a dry bone outside the soft parts, but the difficulty is greatly increased when the bone has to be attacked *in situ*. The plates can only be applied to a little more than one half of the circumference and fragments furthest removed from the surface cannot be fixed. Then the number of plates and screws necessary is so great that there is much danger of shutting out the bone from its chief blood supply from the periosteum.

2. *The Difficulty of Operating upon a Septic Bone Area.*—Every one who has operated upon fractures insists on the overwhelming importance of asepsis. It is only courting disaster to operate upon a case in which the skin is so abraded that it cannot be sterilized. And a bad

* The expenses of this research were defrayed by a grant from the British Medical Association; see SUPPLEMENT, p. 344.

compound fracture in which dirt is ground into the bone is impossible for direct attack. I am not speaking of trivial wounds which heal cleanly within a few days, but of dirty lacerated wounds which lay open the fractured area.

3. *The Difficulty of Applying Non-operative Methods to the Cases under Consideration.*—It is a matter of common experience that a bad compound fracture is one which is most difficult to treat with due regard to the functional usefulness of the limb. I give one example which illustrates the usual results, even when one is keenly alert and applying all possible methods to obtain a good result. A woman was run over and sustained a compound and comminuted fracture of the lower end of the tibia and fibula. Several large fragments of the tibia had to be removed, as they were necrosed and septic, then parts of the overlapping fibula were resected in order to make the two bones of the same length. Next a sliding splint was devised by which an extension of ten pounds was maintained on the foot whilst the wound healed and the fracture united, and yet in spite of this the excessive reaction which always takes place in this type of fracture resulted in such contraction of the parts that the bone ends were firmly joined in a vicious manner with much overlapping. The patient, seen a year after the accident, could walk with a stiff ankle, and she was grateful that her foot had been saved, but she is crippled for life. The main problem to be solved is how to keep up such powerful extension that overlapping of fragments will be prevented, and how to do this in such a way that during the prolonged period of bone healing the joints and muscles may be exercised and the wound dressed without disturbing the fixation of the bone. The nail extension method is undoubtedly the most powerful means at our disposal for applying extension to a fractured bone; I therefore sought to adapt this as a solution of the problem.

Experimental Results.—I made an apparatus consisting of two bars which transfixed the bone transversely, and which were held in place by longitudinal bars at the sides of the limb.

In these cases the bone had been divided by a simple saw cut. The animals could run about within a few days of the operation, and at the end of a week or a fortnight they could do so with little or no limp. The union of the bone was rapid, firm, and accompanied by the minimum of callus formation. Not only do these specimens exhibit the most ideal method of healing, but they show how this transfixion apparatus may be left in place as long as ten weeks without causing any irritation either of the bones or of the soft parts.

Experiments on Severely Comminuted Fractures.—Having obtained a series of successful results with this apparatus in simple fractures, I next applied it to the severely comminuted cases. The skiagrams handed round show the degree of comminution produced (one after twenty-eight days with the fragments and periosteum in place, one after forty-two days with the fragments removed, and one after thirty-five days with the periosteum excluded). If all the fragments and periosteum be left *in situ* a rapid firm union occurs, with some callus excess. If the fragments be removed the union is very slow, as it only takes place by bone proliferation from the ends of the main fragments. Now if the periosteum be excluded, union takes place, but rather slowly, by reason of the bad vascular supply of the fragments.

Clinical Application.—I will only give two examples of the application of this method in human surgery. One is from the leg of a man with comminuted fracture of tibia and fibula. The skin was so contused over the seat of fracture that direct operative exposure was inadvisable. He wore the apparatus for four weeks; he had good functional result at the end of three months, and there was good union of the bone with no shortening.

The other example is from a similar case, and the apparatus had the effect of replacing the comminuted fragments in almost perfect anatomical position.

The method is not so readily adapted for the femur and humerus, because of the impossibility of transfixing the proximal portion of these bones. I attempted at first to overcome this difficulty by using an apparatus which transfixed the lower end of the femur and took a bearing above from a ring like that of a Thomas's knee splint. This, however, does not come up to my ideal of mechanical efficiency, and I feel sure that a better apparatus is one like Lambotte's "fixateur," which transfixes the bones from one side only. (The author then showed some cats which had been the subject of comminuted fractures involving about a third of the shaft of the tibia. They retained both the shape and function of the leg at periods varying from ten days to four weeks after the operation.)

PROSTATISM—THE PATHOLOGICAL BASIS OF THE OPERATIVE TREATMENT.

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THE favourite method of operative treatment of prostatic dysuria, as practised in this country and throughout a large part of the surgical world, is suprapubic prostatectomy according to Freyer's method. This operation has won for itself a pre-eminent position in the domain of surgical practice, and by means of it prompt and complete relief have been frequently afforded for a most distressing ailment that rapidly undermines the patient's health. The great advance that has taken place in the treatment of certain varieties of prostatic disease by Freyer's operation can be gainsaid by no one, and in this paper I shall have occasion to show how suitable it is for a certain type of case. At the same time, it will be shown that there are cases of prostatism for which it is unsuitable, and I shall particularly refer to its utility for the earlier manifestations of the disease for which it is executed, and consider the best means of treating such cases.

Although it is the rule for a speedy and complete recovery to take place after suprapubic prostatectomy, the operation is undoubtedly associated with a high mortality, and sometimes is followed by disagreeable complications, despite the brilliant results of a limited number of surgeons. Reasons may be advanced to account for this state of affairs on clinical grounds, but an accurate conception of them can only be obtained after the surgical pathology of the disease is studied in the light of the operative treatment. It is the object, therefore, of this paper to consider the question of the treatment of prostatic dysuria from the standpoint of its pathology and the pathological findings observed in the parts removed by operation, in cases terminating fatally and in cases dying naturally of the disease. Material of this nature has been examined from 134 cases.

Definition of Prostatism.

The prostate gland is frequently the site of disease which produces local deformity of the organ, interference with the complete emptying of the bladder, damage to the genito-urinary tract above, and serious ill health to the patient. The clinical indications of these are designated "prostatism."

Varieties of Disease Producing Prostatism.

It is recognized that prostatism may arise from a variety of pathological lesions. The majority produce hypertrophy of the gland; all are of the nature of chronic prostatic disease and at one period are amenable to direct operative treatment. In 134 cases examined three outstanding varieties of disease were present: (1) Prostatic hypertrophy or chronic lobular prostatitis, 110 cases. (2) Prostatic fibrosis or chronic interstitial prostatitis, 10 cases. (3) Prostatic carcinoma, 14 cases.

Prostatic Hypertrophy or Chronic Lobular Prostatitis.

The frequency of incidence of this variety of disease as the cause of prostatism is such as apparently to lead occasionally to the belief that it is the only cause. Its etiology has been the subject of much dispute. Thus, Wilson and McGrath, in their recent article, enumerate some thirteen different theories that have been advanced to explain its origin. I do not propose to enumerate these, but would suggest that the changes met with in this disease are in their essential nature so closely identical with those observed in another accessory sexual gland—the female breast, when the site of multiple cystic disease

or chronic lobular mastitis—that their origin probably resides in factors that are essentially identical. It appears to me likely that prostatic hypertrophy will be found to owe its origin to some alteration in a normal internal secretion.

I do not consider the changes found in prostatic hypertrophy, or as I would prefer to call it chronic lobular prostatitis, to be indicative of a truly neoplastic process. In my opinion there occurs a senile hyperplasia, an aberrant overgrowth of tissue, not the result of the appearance of an independent new growth, but possessing a pronounced liability to develop into the same and become a carcinoma. The disease is virtually always associated with a great increase in the size of the gland, but it is occasionally met with in glands that are even smaller than normal, but clinically have produced pronounced indications of prostatic dysuria. Tandler and Zuckerkandl, as a result of their investigations made on subjects dying naturally with prostatic hypertrophy, have shown that prostatic hypertrophy is always found involving the middle lobe. In those cases that I have examined it is undoubtedly by far and away most commonly met with in that situation, but it is also clear that the lateral lobes are frequently also involved. In one specimen the disease was confined to the anterior lobe. This latter condition is, however, unique (Fig. 1).

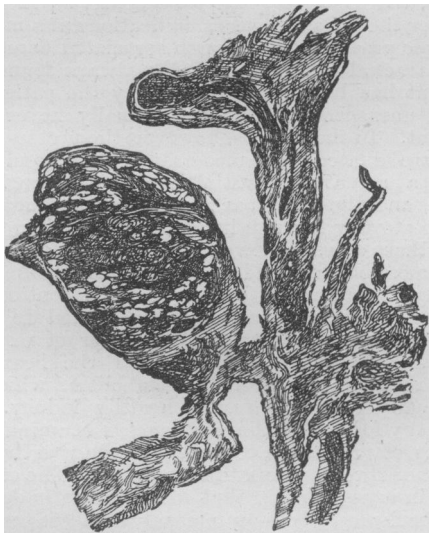

Fig. 1.—Median sagittal section, prostate, showing chronic lobular prostatitis (prostatic hypertrophy) confined to anterior lobe.

When the prostate gland, the site of chronic lobular prostatitis, is sectioned and examined, it is usual to observe areas of glandular overgrowth scattered irregularly throughout its substance. These most usually form spheroids of varying size, and are surrounded by a ring of prostatic tissue that has been uninvolved in the disease, and become compressed to form a coarse trabecula throughout the gland. This displacement and condensation results in the formation around the periphery of the diseased organ of a thick layer of fibrous tissue, non-striped muscle, and compressed and degenerative glandular acini, which is known as the false capsule. It will be found that between the false capsule and the area of disease the flattened out glandular acini form a line of natural cleavage that permits of the easy separation of the diseased tissue beneath from the false capsule surrounding it. In a typical case these flattened acini form an arrangement somewhat like the perforation around a postage stamp, the perforation being, however, longer and the bridges much further apart. Very occasionally a spheroidal area of hypertrophy is seen where the stroma is increased very much in amount, and the gland tissue very much reduced in quantity, so that a fibromyomatous nodule is produced. These are, however, not true neoplasms, and of all the cases where I have observed it in only one did I fail to detect the presence of atrophied gland tissue amidst the fibrous and muscular tissue, and in this case circumstances did not permit of a complete section of the entire gland. These fibroid areas are probably the result of a former inflammatory process.

When the prostate gland enlarges in chronic lobular prostatitis, in addition to producing for itself a false capsule, it usually herniates itself through the internal vesical sphincter, and comes to lie directly beneath the thin mucous membrane of the bladder floor. The disease being confined to the middle and lateral lobes, the seminal vesicles and ejaculatory ducts are displaced into a region of safety.

The class of case above described, of advanced chronic lobular prostatitis, is the ideal one for suprapubic prostatectomy. Glandular hypertrophy has resulted in changes that render the operation possible and usually easy. It is important, however, to remember that cases of this disease are met with that are not ideal for this operation. These are: (1) Cases of chronic lobular prostatitis without hypertrophy; (2) cases of hypertrophy without intravesical herniation; and (3) cases of incomplete false capsule formation.

Prostatic Fibrosis or Chronic Interstitial Prostatitis.

Of the 134 cases I have examined, 10 suffered from prostatic fibrosis or chronic interstitial prostatitis. In this disease the prostate gland is smaller than normal, and is of a firm fibrous consistence. The intraglandular stroma is increased in amount, the whole organ being of a sclerotic nature. When the middle lobe of the prostate is especially involved a fibrous sclerotic bar is produced which mechanically leads to interference with the voiding of urine from the bladder, and a severe degree of retention may result (Fig. 2). When sections of the gland, the site

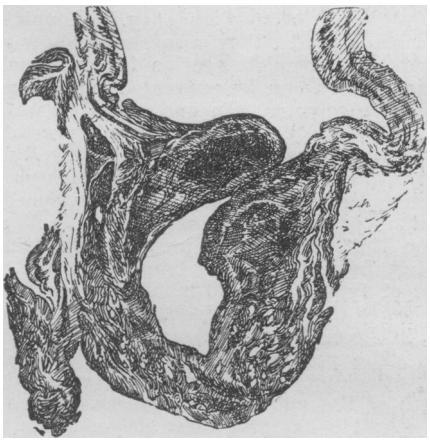

Fig. 2.—Median sagittal section, prostate; chronic interstitial prostatitis, to show median prostatic bar.

of chronic prostatitis, are examined, the appearance seen is very comparable to those observed in a cirrhotic kidney or liver. The glandular tissue is compressed and atrophied by strands of fibrous tissue amidst which portions of degenerated muscles are situated. Throughout the stroma areas are present where small cells, mainly of the lymphocyte type, are accumulated, such as are constantly observed in processes of a similar nature elsewhere. From the point of view of its morbid anatomy, therefore, the prostate gland in which chronic interstitial prostatitis is present differs in almost every respect from that in which chronic lobular prostatitis has occurred. It is perhaps its misfortune that the only features it shares in common are the clinical indications of prostatism that are so closely similar as to tempt certain surgeons to treat them by a similar operative technique, with occasionally disastrous consequences.

Carcinoma of the Prostate.

According to Young's most recent statistics completed from cases in his own clinic, 1 case in 5 of prostatic enlargement causing obstruction in old men is due to cancer. Out of the 134 cases investigated that form the basis of this communication, 14 showed carcinoma of the prostate to be present, or approximately 1 in 10. The clinical records of fully an equal number of cases of cancer treated by palliative measures, the prostate not being removed, exist, but as no material was available for investigating the morbid anatomy, they are, of course, not included; but they go to further confirm the accuracy of

Young's statement of the frequency of prostatic carcinoma. In 10 of the 14 cases prostatectomy was performed, and in 6 of them chronic lobular prostatitis was also present; and had obviously existed antecedent to the onset of cancer, and probably predisposed to its development (Fig. 3).

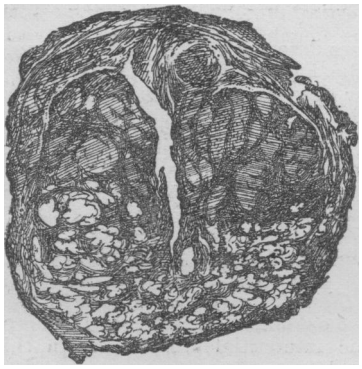

Fig. 3.--Horizontal section, prostate; medullary carcinoma.

Three types of carcinoma were found: (1) Scirrhous, (2) medullary, (3) adeno-carcinoma. They were very comparable to the types met with commonly in the female breast and showed a similar degree of malignancy, the last, like the adeno-carcinoma of Halsted, being the least malignant. Wilson and McGrath have noted how carcinoma of the prostate is frequently only revealed on careful examination of the specimen after its removal by prostatectomy. In the 10 specimens obtained by me from the operating theatre this proved to be the case. They showed how fortunately at first it is the rule for the malignant disease to commence in the centre of an area of chronic lobular prostatitis, so that at first enucleation is rendered even more easy. Complete celloidin sections being made, they also showed how necessary it is to obtain a complete section for examination before a certain opinion can be expressed on the presence or absence of carcinoma. In one case this was especially borne out. The patient underwent prostatectomy, a "lobar" removal being carried out. Clinically carcinoma was not suspected, and the case with which prostatectomy was accomplished, combined with the speedy and uneventful recovery of the patient, did not arouse the suspicion that cancer was present. On examining the specimens, however, it was found that one "lobe" was the site of typical chronic lobular prostatitis, while the other showed the same change, but in addition there was present in the centre of it a mass of carcinomatous new growth. The presence of this was borne out clinically eight months later, when the disease recurred, and led to the death of the patient from cancer. When carcinoma of the prostate has progressed beyond this early stage of centrally situated disease one of three results may follow when the operation of suprapubic prostatectomy by blind dissection is attempted. Either the removal is accomplished with difficulty, a "total" prostatectomy being achieved, or, this being impossible, fragments of the diseased gland are extracted with difficulty, danger, and doubtful benefit to the patient, or the disease is found to be widespread, involving the adjacent blood sinuses and neighbouring glands, and consequently incapable of even partial removal.

Duration of Life and Cause of Death in Untreated Cases.

The frequency with which chronic prostatic disease producing prostatism occurs is difficult to estimate. Richardson states that chronic prostatic enlargement has been found in 34 per cent. of men over the age of 60, of which number 15 per cent. suffered from symptoms. Plondke has estimated that 33 per cent. of all men over 50 years of age suffered from enlarged prostate, and that 10 per cent. of these require treatment. He also says that catheter life results in a 100 per cent. mortality within an average period of four years. In cases dying naturally of prostatism, two forms of death are observed. In one a sudden renal infection brings the patient to a surgeon, under whose care he rapidly expires, with or without operative treatment, from acute consecutive suppurative nephritis. In these cases the organism has usually entered the blood stream from a focus of infection in the lower urinary tract and been determined to the kidney, whose power of resistance to infection has been weakened by prolonged backward pressure.

On the other hand, a slow renal destruction from persistent backward pressure may bring the patient within the care of the physician. The patient's loss of weight, persistent sickness, and failing heart naturally lead to attention being directed mainly to the state of his cardio-vascular system. The prostate is occasionally unsuspected by his medical attendant as the primary cause of his illness, and he dies, breaking up in a manner that is characteristic of so many medical ailments. Sometimes such a case comes under a surgeon's care at a stage just prior to the final breaking up. At this period the appearance of the patient is sometimes most deceptive. His general health is stated to be good. The amount of urea present in the urine is diminished but to no excessive degree. The ordinary tests of renal functional activity, when employed, indicate a certain degree of renal insufficiency. The surgeon may operate and the patient dies, slowly sinking from no obvious or apparent cause of complication, and at the *post-mortem* examination the ureters are frequently found to be dilated to an extreme degree, and the renal pelves dilated to such an extent that the parenchyma is reduced to a thin rim on the surface of two thin-walled multilocular sacs, which are all that represents the kidneys.

During the *post-mortem* examination of patients who have died of various diseases in the medical wards of the hospital, there can frequently be observed, in male subjects over the age of 50 years, indications of a mild degree of chronic prostatic disease with associated damage to the urinary tract above. It is virtually always found that no complaint has been made of this by the patient. It is usually unsuspected, and has virtually never received treatment. In these cases, however, the ureters and renal pelves are dilated to a moderate extent, and there is present a recent interstitial nephritis throughout both kidneys, and the renal parenchyma shows indications of pressure atrophy through its substance. When the pathology of these cases is viewed by one with a surgical mind, it is impossible to avoid the conclusion that the renal destruction as a result of the partial retention of urine from the prostatic disease has contributed to a certain extent to lowering the patient's power of resistance to a general infection, or has poisoned the heart muscle by the retained products of metabolism, which should be normally excreted by the healthy kidney. A most noteworthy feature of the *post-mortem* examination in all the cases of prostatism examined by me was the constant presence of chronic interstitial nephritis. The explanation of this, in my opinion, is that it is frequently due directly to the backward pressure present in these cases. The appearances seen suggested strongly that in those cases where the renal change was of long standing and had obviously existed before the onset of the prostatic disorder it had become aggravated further by it.

Operative Treatment.

The mortality associated with the operation of prostatectomy is high. The mortality of 1,000 cases operated on by Freyer is returned by him at 5.5 per cent. The operation of perineal prostatectomy has been especially practised in America by Young. He reports that out of 450 cases of benign disease 17 died, a mortality of 3.77 per cent. These results, from the point of view of successful operations, appear to be the best in existence. It must not, however, be assumed that these figures approximate even closely to those obtained in the wards of the general hospitals in this country and abroad.

Space will not permit of my quoting full statistics, but it can be confidently asserted that in these institutions the mortality from prostatectomy is approximately from 20 to 25 per cent. In this connexion Rovsing's remarks, when speaking of the results obtained by Freyer and Young, are of especial interest. He says:

> We must not let ourselves be led into believing that this is the real mortality of the operation as regards the great number of surgeons; you will find a far higher rate of mortality from this operation in the wards of the large hospitals all the world over. In my opinion, this is not due only to deficient technique as compared with that of the specialist. Perhaps, least of all so, but far more to the advanced stages of disease of the cases. The true mortality certainly cannot be estimated at less than 10 to 20 per cent.

We have observed, when considering the pathology of those cases that died from prostatic disease without

receiving treatment, how prostatism, if untreated, rapidly undermines the patient's health and power of resistance to infection, so that many patients are really in a dying condition when they come under the care of a surgeon. Page has compiled from the statistical returns of St. Thomas's Hospital returns that form a most interesting comparison in this connexion. He has collected the cases of prostatic disease that were admitted to hospital, and tabulated these according to the variety of treatment they received. The total number of cases treated was 132, and the mortality over all was 21.7 per cent. Those treated by catheterization had a mortality of 22.7 per cent., those treated by suprapubic drainage a mortality of 20 per cent., and those by suprapubic prostatectomy a mortality of 20.3 per cent. The value of these latter results is wherein they show the extent to which the patient's health was broken down prior to any surgical treatment, however simple, being adopted for the relief of the disease.

Cause of Death after Prostatectomy.

From the records of St. Thomas's Hospital, Page has constructed a statistical analysis of the cause of death after suprapubic prostatectomy. For our present purpose it is sufficient to mention that of the 15 fatal cases examined by him 10 died within a week of operation, and the majority of these from an acute local infection or from acute suppurative nephritis. An analysis of the 68 fatal cases that have occurred in the hospital to which I am attached has given a very similar result, and has gone to show that by far and away the commonest cause of death after suprapubic prostatectomy is septic absorption, arising out of the wound inflicted. And secondly, it has shown the fact that the majority of cases of prostatism operated on in the wards of a general hospital are extremely "bad lives" from the actuarial standpoint, on account of the pronounced degree of chronic renal disease from which they suffer.

Local Results of Prostatectomy.

A considerable amount of discussion has centred round the questions, What is removed when suprapubic prostatectomy is performed? and What remains of the gland after the operation is completed? When Freyer's operation is performed for hypertrophy or chronic lobular prostatitis, the tissue removed is found to come away in one of four different methods: (1) "Total" enucleation along with the prostatic urethra. (2) "Total" enucleation with conservation of the prostatic urethra. (3) Lobar enucleation. (4) Nodular enucleation. The main factor that determines the manner in which the diseased tissue is removed is neither the skill nor the dexterity of the surgeon, but the nature of the disease present in the gland.

1. *Total Enucleation with the Prostatic Urethra.*

Where a so-called "total" enucleation is performed and the prostatic urethra removed along with the mass of diseased tissue, it will be found that, although it conforms in the main to the size and structure of the enlarged prostate felt before operation, fortunately for the patient a true "total" extraction of the entire gland is never accomplished. In order to realize exactly what has been accomplished, the information gained in the operating theatre should be contrasted with the morbid anatomy commonly met with in cases of this disease that have died without operation and compared with the features seen in complete sections made of the tissue removed and of sections made of the prostatic bed and adjacent viscera in cases that have terminated fatally after the operation.

It is the experience of every surgeon who has performed the operation of suprapubic prostatectomy on several occasions to note the ease with which the large "adenomatous" hypertrophied prostate is frequently removed. The thin mucous membrane covering the mass projecting into the bladder is scratched through without difficulty. The line of cleavage is easily found. The finger sweeps readily round the mass of tissue, which is enucleated with celerity and in comfort, being held for an instant only, when the tough mucous membrane of the urethra is being torn through. The bleeding at the time is in no way alarming, and is soon naturally controlled. The cavity or prostatic bed out of which the tissue has been extracted contracts at once to a size approximately half of that of the structure it previously contained. The prostatic bed is felt to possess a smooth lining, and the inner vesical sphincter can be made out as a muscular ridge between the bed below and the vesical cavity above. When the morbid anatomy of such a case dying without operation is examined, it will be noticed how Nature would here appear to have designed the parts for the performance of suprapubic prostatectomy. The main bulk of the gland forms an intravesical projection covered by a thin and atrophied mucous membrane. The internal vesical sphincter is dilated and crushed into a region of safety, and surrounds the base of the intravesical mass. Damage to it is virtually impossible. The line of cleavage between the false capsule formed by the condensed, uninvolved prostatic tissue and the diseased lobes is distinctly defined by the flattened and atrophied gland acini, which form the ring of "postage stamp" perforations that have already been described in referring to the morbid anatomy of the disease. The process being confined to the middle and lateral lobes, the ejaculatory ducts and posterior lobe are displaced into a region of safety, and are separated from the area of hypertrophy by the thick-walled false capsule. This latter membrane also serves as a thick protecting coat to the large blood sinuses lying between the sheath and true capsule. The external vesical sphincter is also safe from any possible source of damage. When the tissue removed in such a case is examined, it will be noticed to possess the typical appearances of prostatic hypertrophy or chronic lobular prostatitis already described. Serial sections never reveal the presence of the ejaculatory ducts within it or of striped muscle fibres coating the specimen. A fatal issue may ensue even in such a case, however, and a further opportunity be afforded of observing what the operation accomplished locally. In order to investigate this latter question I have studied the pathology of eight fatal cases following prostatectomy. The pelvic viscera were hardened *in situ*, and thereafter complete celloidin sections of the prostatic bed and adjacent viscera were made and examined microscopically. For our present purpose one typical case will be referred to.

The case was that of a man who suffered from typical prostatic dysuria from prostatic hypertrophy. The gland was extracted without difficulty. He died, however, on the fifth day from pelvic cellulitis, owing to infection through the space of Retzius. Fig. 4 is a vertical median (sagittal) section traversing the prostate and prostatic urethra, which was removed.

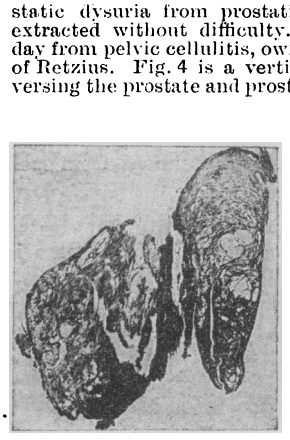

Fig. 4.

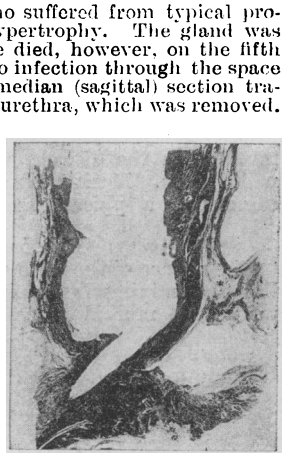

Fig. 5.

Fig. 4.—Median sagittal section of prostate and prostatic urethra removed by the operation of suprapubic prostatectomy for chronic lobular prostatitis (prostatic hypertrophy.

Fig. 5.—Section of prostatic bed in fatal case after prostatectomy. Median sagittal section of prostatic bed after "total" prostatectomy, showing dilated internal vesical sphincter, false capsule, posterior lobe and external vesical sphincter. The seminal vesicles are seen on section between the bladder and rectum and the ejaculatory duct can be observed passing downwards and forwards and traversing the false capsule of the prostatic bed and opening into its lower limit. Between the ejaculatory duct and the rectum the compressed tissue of the posterior lobe is seen.

Fig. 5, a similar section of the prostate bed left after removal. Fig. 6 is a composite superimposed photograph with the gland replaced within the cavity from which it was extracted by operation. Owing to the contraction of the cavity of the prostatic bed, the photograph of the prostate had naturally to be reduced in size to permit of this. When Fig. 5, showing the prostatic bed, is examined, it will be noticed that the stretched internal vesical sphincter surrounds the upper vesical entrance to the cavity. The thick, smooth covering of the false capsule lining the space is visible. Microscopic examination shows this coat to consist of condensed prostatic tissue, consisting

mainly of muscle fibres and fibrous strands with compressed and atrophied gland acini amidst the fibres. The ejaculatory duct is clearly shown traversing the posterior wall of the space from the seminal vesicles above. Below and behind the ejaculatory ducts the compressed and atrophied posterior lobe is seen lying between the false capsule and space of Denonvillier. The undamaged external vesical sphincter and recto-urethralis muscles are seen beneath the prostatic bed. Fig. 6, where the

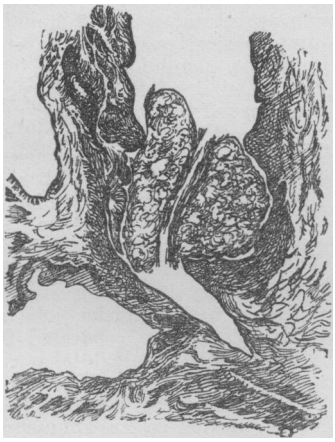

Fig. 6.—Drawing of photograph obtained by the superimposition of Figs. 4 and 5 to show the situation occupied by the enlarged prostate prior to its enucleation by operation.

tissue is superimposed within the cavity from which it was extracted, conveys in a manner more lucid than verbal description, the exact nature of the operation where a "total" enucleation of the prostate gland is accomplished by the operation of suprapubic prostatectomy.

Even in the case above described, serial sections showed that, at the margin of the lateral lobes, nodules of diseased prostatic tissue had remained behind within the false capsule.

2. *Total Enucleation with Conservation of the Prostatic Urethra by Suprapubic Prostatectomy.*

The determining factor in this operation is the consistence of the anterior commissure. Where there is situated in front of the urethra a mass of tissue tough in consistence and virtually devoid of disease, the finger is deflected naturally towards the urethra as it passes over the front of the gland and sweeps behind the urethra, conserving it wholly or in part in consequence. In such cases it will usually be found that the lateral lobes are not widely involved in the disease, which is mainly confined to the middle lobe. Horizontal sections of specimens from such cases show a typical horseshoe contour.

3. *Lobar Enucleation.*

The nature of the false capsule formed by the disease is the determining factor in such cases. In those cases where the morbid process is more lobar than lobular a

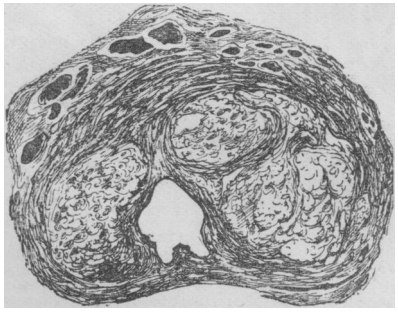

Fig. 7.—Horizontal section of prostate and prostatic urethra. From a case dying without treatment of chronic lobular prostatitis (prostatic hypertrophy); showing disease involving both the lateral lobes and producing a false capsule around them. Note the situation of the large blood vessels of the prostatic sinus on the outer surface of the false capsule.

thick false capsule surrounds the lobes and their separate enucleation is most easy and most likely to be accomplished. The appearance in sections of the tissue removed is characteristic (Fig. 7).

4. *Nodular Enucleation.*

The nature of the false capsule is here again the determining factor in explaining the result achieved. In discussing the morbid anatomy of prostatic hypertrophy or chronic lobular prostatitis, it was pointed out that the change that led to the formation of the false capsule surrounding the gland was not confined to that region, but took place in a similar manner between individual spheroids. In those cases where the tissue removed is extracted in individual nodules of varying size, it will be

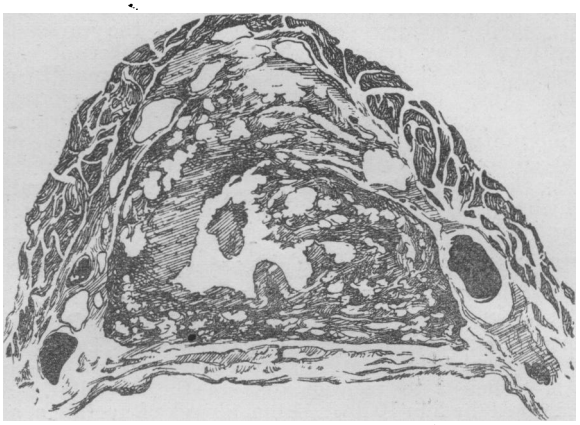

Fig. 8.—Section of prostatic bed in fatal case after prostatectomy, showing thick false capsule consisting of prostatic tissue that remains after "total" enucleation. The condensed tissue of the posterior lobe lies between the prostatic bed and rectum.

observed that the external false capsule is imperfectly formed, and the finger is in consequence deflected into the lines of separation that pass into the gland and separate the individual spheroids. It has already been mentioned that in addition to the case already described, the pelvic viscera of seven other cases that died after the operation of prostatectomy were hardened *in situ*, and serial sections made of the prostatic bed and neighbouring viscera (Fig. 8). Certain of these illustrated some of the complications with which the operation may be associated. In only one of the eight fatal cases examined were the ejaculatory ducts found to be seriously damaged. In five of the eight the false capsule was torn, and the pericapsular space infiltrated with blood and infected. In one case where a nodular removal was practised numerous fragments of diseased prostatic tissue had been left, and were seen projecting into the prostatic bed. In such a class of case it is not difficult to account for the liability for the obstruction to recur after the operation is recovered from. Microscopical examination of the prostatic bed of the eight cases showed it to consist of muscle and fibrous tissue and compressed gland acini, as already described, and in all cases it was the site of an acute suppurative process. In all cases small septic thrombi were present in the smaller vessels, and in two cases large septic thrombi were also present in the large veins of the prostatic sinus.

The question may now be considered whether a total extracapsular complete enucleation of the prostate gland is ever accomplished by blind finger dissection in the course of the operation of suprapubic prostatectomy. In certain anatomical textbooks the student is led to believe that this is what the surgeon aims at and usually accomplishes. Thus, for example, the most popular student textbook of anatomy states:

> Immediately surrounding the prostate, and quite independent of the sheath, is the fibrous capsule of the prostate. This capsule varies in thickness, in some cases being extremely thin, in others forming a distinct cortex. In association with operations for the removal of the prostate, now frequently performed, it is important to notice that the capsule has but very slight connexion either with the venous plexus or with the sheath of pelvic fascia. It is on this account that the gland can be so easily shelled out from its surroundings.

So far I have only obtained one specimen of this nature. It was presented to me by a graduate, and in addition to the complete prostate the seminal vesicles had been removed along with portions of the vasa deferentia, which hung like tentacles to the specimen. When the specimen was sectioned it showed the gland to be the site of chronic interstitial prostatitis. I was informed that it was removed with the utmost difficulty. This was not surprising. No further history was obtainable.

Cases are, however, not rare where a partial extracapsular removal has been carried out. In the operating

theatre these are difficult cases, and when the specimen is examined after removal portions of striped muscle fibre are found on its surface and a portion of one of the veins of the prostatic sinus may be adherent.

From the lower apex of the gland a tongue of tissue frequently projects, which contains muscle fibres derived from the external vesical sphincter. These are usually either cases of diffuse chronic lobular prostatitis, where no spheroids are formed, or combined lobular and interstitial prostatitis, or cases of early carcinoma (Fig. 3). The case from which this last specimen was obtained terminated fatally, and the *post-mortem* examination showed the false capsule to have been torn and early secondary carcinoma present in the lymphatics. I have not had the opportunity of examining *post mortem* a case of fibroid prostatitis treated by prostatectomy. If, in such a case, the prostate is enucleated, it is easy to deduce what is likely to result from what has been already described as the morbid anatomy of this disease.

Conservative Perineal Operation of Young.

In Young's operation the surgeon is afforded at the time of operation a full view of the dissection he executes, consequently the same dubiety as to the structures divided and removed does not exist. The material examined by me was obtained from 10 cases, all of which were operated on by myself. When the tissue removed was sectioned and examined microscopically it showed the lobes to be masses of tissue the site of chronic lobular prostatitis, and demonstrated the fact that the lobes were the product of no natural anatomical division of the gland, but resulted from the separation of a common mass of diseased tissue into three more or less artificial divisions.

The Choice of Operation based on the Pathology of the Disease.

In discussing this question we are met at the outset by the opinion already expressed when considering the pathology of certain "ideal" cases of advanced chronic lobular prostatitis, where it was said "that Nature would appear to have designed the parts for the operation of suprapubic prostatectomy." We will therefore consider the question from two standpoints: (1) The factors contributing to the relatively high mortality met with in those "ideal" cases, when treated by suprapubic prostatectomy, and how far it is possible to diminish this by the employment of other methods of operative treatment; (2) the danger of attempting to perform Freyer's operation of suprapubic prostatectomy in cases where the circumstances are not "ideal," the prostatism being due to other causes.

When the first question is considered, the facts concerning the cause of death after suprapubic prostatectomy already mentioned should be borne in mind. It has been already shown that the "ideal" case was the large "adenomatous" hypertrophied prostate, the site of chronic lobular prostatitis, where a large intravesical projection existed, and a thick, complete false capsule was formed. The damage to the patient's health during the period when this mass of tissue was ripening for removal has been also shown; the local and general irreparable damage caused by the prolonged backward pressure on the bladder and kidneys due to the retention of urine have been described. The case may be "ideal" for suprapubic prostatectomy, but the health of the patient has become so permanently impaired that any operation is now to him a most dangerous procedure. The factors that are liable to be the immediate cause of death in such a case have been shown to be: (1) Local infection arising out of the wound inflicted—for example, pelvic cellulitis, suppurative cystitis, consecutive suppurative nephritis, and under this heading may be included also reactionary haemorrhage. (2) The development of a distal septic focus such as bronchopneumonia. (3) Embolism, producing pulmonary infarction, which is always due to an associated infection. (4) Surgical accidents, such as fatal reactionary haemorrhage aud peritonitis. (5) Uraemia, in cases where the damage to the kidneys before operation was so severe that, in the absence of other complications, this revealed itself as the sole cause of death. The underlying cause common to all is thus the weakened power of resistance owing to the prolonged disease. The dangers that are peculiar to suprapubic prostatectomy in an "ideal" case are the wounding of the space of Retzius and the consequent risk of septic pelvic cellulitis, and the risk of pulmonary infection with hypostatic congestion and pneumonia that is present when an elderly patient is confined to bed for some time, as is the general practice after suprapubic prostatectomy. The third risk is the difficulty of providing an efficient drainage of the bladder and prostatic bed so as to prevent a profound septic absorption from the stagnant septic urine that bathes the raw surface of the latter.

We may now ask how far these factors are avoidable by the choice of other means of treating the disease. The choice at our disposal lies between catheter life, the performance of a preliminary suprapubic cystotomy, or perineal prostatectomy. Catheter life may be dismissed at once as only justifiable in the hopelessly inoperable cases of this type. Preliminary suprapubic cystotomy is favoured by some on the grounds that it permits of a certain improvement in the patient's condition prior to the removal of the growth, and improves the condition of the septic bladder, but the value of it is doubtful. Page has shown how the mortality attending this line of treatment is relatively as great as that attending suprapubic prostatectomy, and it has further this disadvantage, that it does not get rid of the main risk of the operation where suprapubic prostatectomy is performed in an "ideal" case, which is pelvic cellulitis due to infection by way of the space of Retzius. A typical case is quoted below to illustrate this danger.

He was a man of 67, upon whom a suprapubic cystotomy was performed with the intention of its being preliminary to a suprapubic prostatectomy. On the night after operation the temperature rose to 103°, and remained high for nine days, when it fell to 100° F. He complained chiefly of pain in the upper part of the abdomen, and died suddenly on the tenth day. The abstract of the pathological record is: Enlarged prostate, backward pressure, pyelitis, pelvic suppurative cellulitis, early bronchopneumonia. The detailed description of the pelvic viscera shows how the pelvic cellular tissue was infiltrated by a thick greenish lymph, which extended up into the retro-abdominal tissues. This area of purulent infiltration extended from the space of Retzius, which had been wounded in the natural course of opening the bladder. The purulent infiltration reached as far as the lower pole of the right kidney. The prostate was increased in size, with a nodule of prostatic substance projecting into the cavity of the bladder behind the urethral opening, and forming the so-called middle lobe of the prostate. This projection was covered with ulcerating bladder mucosa. The bladder wall was hypertrophied, owing mainly to an increase in the muscular coat. The mucous membrane had undergone chronic ulceration, and multiple villous-like projections of indurated mucous membrane projected from the surface. The ureters were somewhat dilated; their walls were hypertrophied and their mucous membranes showed evidences of recent catarrh. The pelves of both kidneys were dilated and showed signs of recent acute catarrh. There was no evidence of suppurative nephritis; there was some chronic interstitial nephritis.

Where perineal prostatectomy according to Young's method is employed for the treatment of this "ideal" case, it is of course associated with risks peculiar to itself, but with it there is naturally no risk of infection of the space of Retzius, which is not damaged. The risk of pulmonary complications is much less, the patient being out of bed on the second or third day; and, finally, every impartial critic will grant that where the technique of bladder drainage is carried out according to the directions laid down by Young, the drainage is as near "ideal" as is possible to achieve, and there is no retention of stagnant septic urine in the bladder and prostatic bed. The unavoidable risks peculiar to Young's operation in such a case are the greater length of time occupied by the operation and the risk of infection of the pelvic cellular tissue planes owing to the opening of the lymph paths when the space of Denonvillier is opened into. This latter would appear, however, to be more a theoretical than actual danger, as it has not been encountered by Young in his numerous cases, and in my very limited experience of ten cases it has never been encountered. The reason for this would appear to be that the time when infection is liable to gain entrance to the cellular tissue is during the hours immediately following the infliction of the wound, before Nature has had time to create the natural protective barrier; and during this period in Young's operation the bladder drain and gauze packs in the prostatic bed prevent the entrance of septic urine in such quantity as to lead to a cellulitis. When the gauze

packs and bladder drain are withdrawn, by the end of the second day, the free dependent drainage prevents septic material accumulating. The importance of this latter fact appears to me to be borne out in my limited experience, where I have noticed how liable such patients are to have a slight rise of temperature and other indications of ill health about the end of the first week after operation—at that period when the external skin wound is closing, but still a day or two before the urine comes by the natural channel. During this brief interval Denonvillier's space is liable to be distended with septic material for the first time during the course of operation. This passing phase of septic absorption, if my explanation be correct, bears out the well-known surgical dictum: "That man does not die from sepsis on a free surface; it is the confinement of sepsis that the surgeon fears after operation."

The avoidable risks peculiar to perineal prostatectomy are probably more dreaded by certain surgeons. The reality of them no one familiar with the operation will gainsay. None of them are, however, such as to be likely to lead to a fatal issue. The position as regards the operative treatment of the "ideal" case of prostatic hypertrophy due to chronic lobular prostatitis may, therefore, be briefly stated to be that the simplest, most rapid, and, speaking broadly, the safest method of treatment is Freyer's operation. When it is performed it is of the utmost importance that the skin wound should not be sutured, so as to minimize the risk of prevesical infection. Efficient drainage of the bladder and getting the patient out of bed as early as possible are of equal importance. Perineal prostatectomy in such cases, in skilful hands, may produce an equally good result, but is more liable to be followed by such post-operative complications as stricture, fistula, or partial incontinence. In the hands of those unfamiliar with the accurate steps of the operation and its after-treatment, it is a much more dangerous method of treatment for this class of case. Thus on practical and theoretical grounds we may reaffirm that Nature would here appear to have designed the parts for the operation of suprapubic prostatectomy.

The Operative Treatment of Cases of Prostatism where the Disease is not Ideal for Suprapubic Prostatectomy.

We have seen how in this class there are included: (1) Cases of chronic lobular prostatitis or prostatic hypertrophy without glandular enlargement; (2) cases of chronic lobular prostatitis without intravesical projection; (3) cases of chronic lobular prostatitis without the formation of a complete false capsule; (4) cases of chronic interstitial prostatitis where the disease is generalized or has led to the formation of a median prostatic bar; (5) cases of carcinoma of the scirrhous type or involving the capsule.

The danger of attempting to perform Freyer's operation in such cases is known to every surgeon who has endeavoured to do it. At the same time it should be remembered that Freyer's position as regards such cases is perfectly clear. In speaking of cases suitable for suprapubic prostatectomy, he says:

> In patients in the earlier stages of the malady in whom not more than an ounce or two is found on introducing the catheter, it is inadvisable to attempt the removal of the prostate, because the enlargement of the organ will not have sufficiently advanced to render it prominent in the bladder or to define adequately the lines of cleavage between the true capsule of the prostate and its enveloping sheath. When we have to deal with adenomatous enlargements of smaller dimensions, say less than 1½ oz. in weight, the greatest difficulties present themselves as to the possibility of their enucleation entire being practicable.

It is important to bear in mind, however, in addition to early cases with a smaller quantity of urine, the most pronounced cases of prostatism with the severest degree of backward pressure are frequently met with in cases where the prostate is not enlarged or only slightly so, and where the gland in consequence maintains its normal relationship to the surrounding structure. In treating such cases, therefore, the courses open to us are: (1) To delay and wait for the gland to ripen to the maturity necessary for the satisfactory performance of suprapubic prostatectomy, a procedure surely unwarranted as a sound surgical practice in the light of the damage done to the urinary tract and the whole body by delay. (2) To endeavour to enucleate the gland by suprapubic prostatectomy. (3) To seek in another operation a satisfactory means of treating such cases. The risks associated with the second course where suprapubic prostatectomy is practised in the types of disease mentioned are numerous, and have been already referred to. Thus, in chronic interstitial prostatitis and advanced carcinoma, the operation is practically impossible. Its attempted performance is advised by no surgeon of standing, but, at the same time, cases have occurred where it has been attempted, and I have referred to one where a complete extracapsular removal of the entire gland was achieved by this means. The dangers of such a procedure are too obvious to warrant repetition.

Where glandular hypertrophy without intravesical projection is present, it can of course be diagnosed by cystoscopic examination, or, better still, examined with a urethroscope such as Wossidlo's or a cysto-urethroscope. I am afraid, however, that in many cases it is only when the bladder is opened that the condition is discovered. Suprapubic prostatectomy in such a case necessitates damage and probably destruction to the internal vesical sphincter. It is likely also that in these cases the line of cleavage between the area of disease and false capsule will be more difficult to find. The result is the operation is much more difficult and the extracapsular lymph space will probably be opened into, and the grave risk of septic pelvic cellulitis encountered in consequence.

There remains, lastly, the case where the false capsule is imperfectly formed to be considered. I claim to have already shown that these cases are occasionally met with, and we have seen how, when suprapubic prostatectomy is done in such cases, the tissue is removed, usually in fragments, with the risk of leaving portions as possible future causes of obstruction. In this class of case, again, the dangerous lymph area between the capsule and sheath may be opened into. We may therefore consider that in all the classes of cases mentioned Freyer's suprapubic prostatectomy is unsuitable.

THE OTHER OPERATIVE PROCEDURES SUITABLE FOR THESE CASES.

Those comprise: (1) Perineal prostatectomy; (2) division of the median bar by Bottini's galvano-cautery or its modifications, or by Young's more recently introduced prostatic punch; (3) suprapubic transvesical prostatectomy by the transperitoneal route or extraperitoneal with visual dissection. The scope of the second variety of operative treatment where the cautery or punch is used is clearly defined. They are the procedures of choice for cases of chronic interstitial prostatitis, especially with median bar formation.

Perineal Prostatectomy.

Cases of chronic lobular prostatitis (prostatic hypertrophy) without glandular enlargement are particularly suitable for this operation. In this type of disease the false capsule was well formed in the cases I have examined. The entire gland, however, is situated below the bladder floor and separated from that cavity by its mucous and muscular coats. By means of the operation of perineal prostatectomy, if properly executed, the area of disease may be entirely removed without damage to the internal or external vesical sphincters. If, at the same time, the surgeon, following Young's instructions, cuts deeply into the individual lobes by the incisions made parallel to the course of the prostatic urethra, the compressed tissue of the posterior lobe will be divided and the line of natural cleavage reached that allows of the easy removal of the diseased tissue in the separate portions described as lobes by Young. It has appeared to me that the importance of making this incision of a necessary depth in all cases where Young's operation is performed, so that the posterior lobe is divided completely, is perhaps not always fully appreciated when this operation is performed, and it is rendered much more difficult in consequence owing to the natural line of cleavage not being reached by the shallow cut made.

Where perineal prostatectomy is done for cases of chronic lobular prostatitis with general enlargement without intravesical projection or with an imperfectly formed false capsule the dual sphincter can always be conserved. The absence of the false capsule will of course render the removal more difficult, but as this is an operation whose technique is that of a visual dissection and not a blind finger enucleation, as in the suprapubic operation, this

difficulty is not anything like so serious. Further, the wounding of the extracapsular lymph space which is liable to occur and was referred to as a serious complication in the suprapubic operation is not here of serious consequence, because owing to the reasons already given the space is not liable to the same degree of septic infection, and the drainage it receives is so thorough as to mitigate against the risk of cellulitis arising from this cause. If the large veins beneath the sheath are wounded, the bleeding vessel can be seen and controlled by ligature and serious haemorrhage thus prevented.

The treatment of carcinoma by perineal prostatectomy has been shown by Young to be possible even in those cases where the capsule and base of the bladder are invaded. If the tumour is adherent to the rectum behind, the risk of damage to the bowel is correspondingly very much increased. Young has removed the entire gland along with the seminal vesicles and a portion of the bladder floor, a procedure impossible by the suprapubic route. It is only fair, however, to remember, when considering the treatment of prostatic carcinoma, that in many cases the disease, when early, has been removed with ease by Freyer's operation. This has, however, been accomplished when the malignant nature of the growth was clinically unsuspected, and usually owed its success to the co-existence of chronic lobular prostatitis, upon which the malignant process had supervened. This latter fact is a further reason for advocating early operative interference in all cases of prostatic dysuria, and it does not directly influence the question of the treatment of the disease when clinically recognizable. I think most will agree that in the light of the pathology of prostatic carcinoma and the results obtained by Young, Willan's advice, as given in his recent article, is unduly pessimistic, when he recommends that where a diagnosis of cancer of the prostate has been made clinically the performance of a radical operation for the removal of the disease is not to be recommended. When 20 per cent. of cases of prostatic enlargement or obstruction in old men are recognized as clinically due to carcinoma, such advice is surely unwarranted.

Suprapubic Transvesical Prostatectomy by the Open Method.

This method of treating prostatic disease is being more generally practised in recent years. It is possible that when visual accurate dissection has replaced blind enucleation, an "ideal" operative technique for the treatment of the above varieties of prostatic disease may be elaborated by this route. Accurate removal and perfect control of haemorrhage would thus be possible. On the other hand, however, it is obvious that if the route is transvesical it must necessitate serious damage to the bladder in many cases to reach an organ that is frequently entirely extravesical in situation. How far this can be made good by reparative plastic surgery as a final procedure in the technique of such an operation can only be conjectured.

CONCLUSIONS.

The conclusions as regards the treatment of prostatism from the standpoint of the pathology of the diseases causing it appear to me to be:

1. Three outstanding varieties of disease lead to prostatism: (*a*) Prostatic hypertrophy or chronic lobular prostatitis. (*b*) Prostatic fibrosis or chronic interstitial prostatitis. (*c*) Prostatic carcinoma.
2. The first is by far the commonest cause of prostatism, and was present in 82 per cent. of the specimens examined.
3. Chronic lobular prostatitis is, in my opinion, a senile hyperplasia, an aberrant overgrowth of tissue that is not the result of the appearance of an independent new growth, but is liable to develop into the same.
4. Chronic lobular prostatitis in the majority of cases produces prostatic hypertrophy.
5. It virtually always develops in the middle lobe, and is almost uniformly confined to the middle and lateral lobes.
6. The gland in consequence undergoes changes that usually permit of its easy removal by suprapubic prostatectomy.
7. Chronic lobular prostatitis may develop in and be confined to the anterior lobe, this being noted by me in one case.
8. Chronic lobular prostatitis may cause prostatism without enlargement of the organ, intravesical herniation, or complete false capsule formation.
9. In these cases the performance of suprapubic prostatectomy is difficult and dangerous.
10. The successful performance of suprapubic prostatectomy depends on the presence of an advanced type of prostatic hypertrophy due to chronic lobular prostatitis.
11. The recognition of this is clinically frequently very difficult.
12. When a patient with this advanced type of disease is operated on, his urinary tract and general health have usually suffered serious damage from the disease.
13. It is therefore unjustifiable to delay operation in an early case of chronic lobular prostatitis in order to permit of the gland undergoing those hypertrophic changes that facilitate its easy removal by suprapubic prostatectomy.
14. The mortality attending suprapubic prostatectomy is mainly due to the impaired health of the patient prior to operation.
15. The actual cause of death in such cases is usually a local infection arising out of the wound inflicted.
16. The operation of suprapubic prostatectomy by blind enucleation is unsuitable in cases of prostatism due to other causes than advanced chronic lobular prostatitis.
17. Perineal prostatectomy is a most suitable operation for such cases.
18. Perineal prostatectomy permits of the removal of the disease when its presence is diagnosed in all cases. It is, therefore, at present the operation that offers the best prospect of further advance in the treatment of prostatism.
19. For its successful performance an accurate knowledge of the anatomical structure and relationships of the prostate are necessary, as well as an understanding of the pathology of the disease.
20. The suprapubic transvesical method of prostatectomy by visual dissection offers the prospect of developing into a method of treating prostatism that may ultimately warrant its adoption in a large number of cases.
21. Chronic interstitial prostatitis is best treated by division and removal of the constriction by the transurethral route.
22. Prostatic carcinoma may be in an early case clinically indistinguishable from hypertrophy due to chronic lobular prostatitis.
23. This fact is, therefore, a further reason for early operation in all such cases.
24. Prostatic carcinoma, when recognized clinically, may be successfully treated by excision of the gland in suitable cases.

I desire to record my gratitude to the President and Fellows of the Royal College of Surgeons of Edinburgh, in whose laboratories this research was conducted.

I wish to thank also many of my senior colleagues, and especially Mr. David Wallace, for permitting me to use material from their private and hospital cases, and Dr. Shennan and the staff of the Pathological Department of the Royal Infirmary of Edinburgh, for the many willing services they have done for me in the course of this investigation.

NEURALGIA OF THE TWELFTH DORSAL NERVE SIMULATING VISCERAL LESIONS.

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NEURALGIA of the intercostal nerves has long been a well-recognized affection, sometimes troublesome to get rid of, but as a rule, under proper treatment, subsiding satisfactorily. The twelfth dorsal nerve, however, from its anatomical relationship and its distribution, presents features worthy of detailed consideration.

During the last twelve years there has frequently come under my observation neuralgia of this nerve simulating visceral lesions so closely as to lead to the performance of laparotomy; indeed, recently a lady came under my

observation whose ovary and appendix had been removed and her kidney excised, but whose only complaint was evidently that of neuralgia of the right twelfth dorsal nerve, as was shown by the complete relief obtained by the division of this nerve.

Why the neuralgia of the twelfth nerve should be so inveterate is probably explained by its anatomical relationships—pursuing its course from under the twelfth rib to above the pubis, piercing the different layers of the abdominal muscles, giving a branch over the crest of the ilium, which branch is necessarily readily injured accidentally or in the course of occupation where weights are carried on the haunch.

Conditions of unrest thus exist as are found in the case of the sciatic nerve, and the resultant neuralgia may be as serious, as far as incapacity to work or enjoy life, as is found in the latter case.

In this nerve, as elsewhere, the neuralgia attack may be mild and quickly passing; but in those cases, 22 in number, on which I have operated the condition had persisted so long and the pain was so great as to make the patient right willingly seek relief by operation.

The functions of the twelfth nerve being mostly sensory, one need have no hesitation in dividing it, though the patient occasionally complains of a sense of coldness and numbness in the region supplied by the nerve; but this, as a rule, soon passes off.

In regard to the areas of pain in such cases, three points will be generally found. A painful area immediately under the twelfth rib, by the outer border of the quadratus lumborum; another to the inner side of the anterior superior spine of the crest of the ilium; and, lastly, an area above and to the outer side of the pubis. We thus have pain suggesting kidney and ovary, and on the right side appendicitis.

Almost invariably an area of tenderness can be determined in the area supplied by that branch of the twelfth nerve which crosses the crest of the ilium. Tenderness in this area has been supposed to be associated with ovarian disease—an association, however, which is not very apparent when one considers the distribution of the nerves. It seems not improbable that many of these cases of ovarian neuralgia and appendix colic unrelieved by operation may really be due to neuralgia of this nerve.

The first case which came under my observation, now twelve years ago, was that of a man of 40, who had for fifteen years spent the greater part of his time as an invalid. He was a working man who in his occupation had frequently pressure on his left haunch. The pain at times was excruciating, with intervals of comparative comfort, but never such as to allow him to get into the full swing of work. He was on his way to the poor-house when sent to me for an opinion. There being no other apparent reason for his suffering apart from neuralgia, I for the first time exposed and destroyed the twelfth dorsal nerve, with relief so immediate and complete that within six weeks he was once more at work, and has continued well.

Another typical case is that of a girl aged 15, who complained of pain in the right side of five years' duration. Five years before admittance she was kicked in the right groin. Sickness and vomiting occurred, and she was confined to bed for a fortnight. There was pain on micturition, but no story of haematuria. At times she noticed a swelling in the right iliac region. Menstruation began at 12 years; at each period pain increased in severity, so much so that she had to stay in bed a day or so. On examination the abdomen was found to be normal, except over McBurney's point, which was tender to pressure.

January 28th.—Pain now confined to right lumbar region and right buttock. No pain in right iliac region.

February 7th.—Resection of twelfth dorsal nerve.

February 22nd.—Dismissed well.

It is unnecessary to multiply clinical cases similar to those described. I have records of 22 cases, all of which, with one exception, were cured by this operation on the twelfth nerve. The case where no relief was obtained had previously been operated on for kidney affection; the wound had suppurated, and in the cicatricial mass it was difficult to find the nerve, and no relief was obtained.

It seems probable that in some cases the ilio-hypogastric may be at fault, but this seems to me less frequent and less likely to occur than in the case of the twelfth nerve. The nerve can be easily exposed through a perpendicular incision by the outer border of the erector spinae.

THE SURGICAL TREATMENT OF INTESTINAL STASIS.

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THANKS to the brilliant advocacy of Sir Arbuthnot Lane, there is an increasing belief as to the necessity for surgical treatment in certain cases of marked intestinal stasis with symptoms of alimentary toxaemia.

In some cases stasis is due to obstruction by definite bands at the termination of the ileum, at the hepatic or splenic flexures of the colon, or in the neighbourhood of the colon. Whether these bands are of developmental or inflammatory origin is of academic interest. The practical point is that they do occur as definite pathological lesions, and are not, as some would have us believe, the figments of the mental kink of a disordered imagination. In other cases—and perhaps these are the more numerous—stasis appears to be due, as has been pointed out by Sir Arbuthnot Lane, to the control by the appendix of the effluent from the ileum into the caecum.

The symptoms produced by intestinal stasis fall into two groups—namely, those produced by obstruction, and those resulting from autointoxication (Lane). Frequently, in intestinal stasis, the prominent symptom is indigestion—that is, pain after food, flatulence, and sometimes vomiting. There are, I think, grounds for believing that these digestive troubles are due to interference with the secretion of the stomach by the action of absorbed toxins. My reason for this belief may be stated briefly as follows:

It is now recognized that in many cases of gastric trouble the *fons et origo mali* is in the appendix; the symptoms are referred to the stomach, but the lesion is in the appendix, a condition for which I have suggested the term "appendicular gastralgia." In many of these cases there is a complete absence of free HCl in the gastric contents. This absence of free HCl has been attributed to inflammatory changes in the gastric mucosa, as a consequence of delay and stagnation of food in the stomach. This explanation does not seem to be satisfactory. After removal of the appendix in these cases I have found in many instances that free HCl is present in the gastric contents although absent before operation. This observation seems to be fatal to the hypothesis that the absence of free HCl is due to inflammatory changes in the gastric mucosa. If the absence of free HCl were due to this cause, it is difficult to believe that after operation there could be an immediate restoration of the secretion of free HCl. This observation is a very striking one, and puzzled me for several years. I used to think that the absence of free HCl might be the result of spasmodic pyloric stenosis, secondary to the irritation of the diseased appendix, and that the removal of the appendix led to the cessation of the spasm of the pylorus, and consequent renewal of the secretion of free HCl. This view seemed to be disproved by the absence of pyloric spasm on *x*-ray examination, and by the observation which I have made a number of times that electrical stimulation of the appendix has no effect in producing pyloric contraction. The hypothesis that the diminution of free HCl in the gastric contents is due to the absorption of toxins from the alimentary canal explains in a reasonable manner the restoration of the secretion of free HCl by the gastric mucosa after removal of the appendix.

Vomiting may be a consequence of toxic gastritis, but when continuous and copious, may be due to a kink either at the junction of the stomach with the duodenum or at the duodeno-jejunal flexure, the kink being the result of the distension of the intestines. In the following case it is difficult to give any other satisfactory explanation of the copious and persistent vomiting which occurred. The patient was a young woman, aged 25, who was under the care of my colleague, Dr. Soltau Fenwick.

For six or seven years she had suffered from pain coming on immediately after food, accompanied by vomiting. Two years previously she was operated on for acute appendicitis, but the appendix was not removed. She gradually got worse, and had two attacks of haematemesis. The pain used to wake her up at night, and she was rarely free from it. With gastric lavage, rectal feeding, and rest in bed she improved for a time, but then began to get worse again, was readmitted, and at Dr. Fenwick's request I operated on her. No lesion was found in the stomach, but the caecum was enormously distended, and at one point bound down by adhesions. Ileo-colostomy was

performed. The patient remained well for three months, and then began to have copious and persistent vomiting accompanied by pain. She was readmitted and kept under observation for several weeks. Notwithstanding all treatment, the vomiting persisted to such an extent that it was difficult to understand how she continued to live and look as well as she did. At night the pain frequently kept her awake for hours. After further consultation with Dr. Fenwick I removed the whole of the colon and the terminal portion of the ileum. The patient made an excellent recovery, has been completely relieved of her symptoms, and feels better than she has done for years.

The simplest method of demonstrating intestinal stasis is to administer two teaspoonfuls of charcoal to the patient, and watch for the appearance of the charcoal in the stools. Non-appearance of the charcoal for seventy or a hundred hours is evidence of intestinal stasis. The site of the stasis and the presence of kinks can be demonstrated by *x*-ray examination, in the technique of which admirable work has been done by Dr. A. C. Jordan. I regard the charcoal test as a very valuable one, and I should hesitate to accept the evidence afforded by *x*-ray examination unless it were confirmed by the charcoal test.

Indications for Surgical Treatment.

When there is evidence of appendicular trouble, of definite kinks, or of obstruction by bands, clearly surgical treatment is indicated. Colicky pain and constant tenderness over the caecum and sigmoid are suggestive of mechanical obstruction. When the stasis is due to atony of the large bowel, or to a large mobile caecum, medical treatment must have had a prolonged and thorough trial and have failed before surgical treatment is considered. It is only in the really severe cases that surgical treatment is indicated. It is scarcely necessary to add that intestinal stasis *per se* does not call for surgical treatment unless it be accompanied by constant pain or by distinct signs of toxaemia.

Operative Treatment.

In a certain number of cases in which the appendix controls the effluent from the ileum into the caecum complete relief is afforded by appendicectomy. Whether this control is due to the appendix acting as a ligament and causing a kink (Lane), or, as seems to me more probable, to the diseased appendix causing spasm of the caecum and end of the ileum, is a question of secondary importance. The frequency with which in these cases faeces or definite concretions are found in the appendix seems to suggest that the hypothesis of spasm is the more probable. The contractile efforts of the appendix to empty itself into the caecum spread to the caecum and lower end of the ileum. Frequently I have seen the appendix contracting vigorously when touched during the operation of appendicectomy. That such a contraction occurs during life is suggested by the severe attacks of pain—the so-called appendicular colic—which may be caused by an appendix which has little wrong with it, except that it harbours a concretion.

My experience is that, after removing the appendix for appendicular gastralgia, about 85 per cent. of the patients gain complete relief. The remaining 15 per cent. continue to suffer from indigestion, due apparently to a chronic gastritis and absence of free HCl. Some years ago I discussed the question whether it is justifiable to perform gastro-jejunostomy in such cases in the absence of a definite lesion of the stomach. I expressed the view that it is not justifiable. Since then Sir Arbuthnot Lane has shed new light on these dark places, and now the indication seems to be that when, after appendicectomy in these cases, the symptoms persist and are of so severe a type as to necessitate further surgical treatment, it is a short circuit between the ileum and pelvic colon, and not between the stomach and jejunum, which is indicated.

In a few cases in which the ileum is bound down by a band of limited extent, it may be possible to divide the band so as to free the ileum completely. Care must be taken to cover over with peritoneum the raw surface left after division of the band. This method of treatment is of limited application. In some instances the results of this simple procedure are excellent, but in others the bands reform. If the membrane binding down the ileum be wide in extent, its division is a hazardous procedure, as it may be followed by paralytic intestinal distension, which may be alarming, and has, I believe, proved fatal in some instances. An ileo-colostomy is safer than extensive division of bands. Division of bands about the hepatic and splenic flexures is not followed by good results. Bands about the sigmoid, on the other hand, I have divided in a number of cases with excellent results.

Ileo-colostomy is a safe, and in the majority of cases a satisfactory, operation. The proximal end of the ileum may be anastomosed to the pelvic colon by an end-to-end or by a lateral anastomosis. Personally, I prefer the lateral method, because one of my patients upon whom I performed an end-to-side anastomosis, subsequently required a secondary lateral anastomosis owing to contraction of the original end-to-side union. It is asserted constantly that patients after ileo-colostomy suffer from troublesome diarrhoea. I can only say that I have never met with this complication. On the contrary, I find that as a rule such patients have to continue the use of liquid paraffin to ensure a regular action of the bowels. The only objection to ileo-colostomy is that sometimes the patients continue to have some discomfort or pain owing to reflux of faeces into the colon, or more probably to distension of the large bowel with gas. I have referred already to a case of this kind.

Just over 25 per cent. of my patients have suffered more or less from this sequel of ileo-colostomy. My experience may be exceptional, but if this trouble occur as frequently as this, it raises the question whether colectomy should be performed at the same time as the short circuit, to guard against the disappointment of an incomplete cure. A combined ileo-colostomy and complete colectomy is a big operation, and does not appear to me to be justifiable except in exceptional circumstances. For this reason I have adopted latterly a method of partial colectomy, which Dr. Mayo has informed me he has employed successfully in several of these cases. This method consists in dividing the ileum and anastomosing it to the transverse colon in an antiperistaltic direction, and then resecting the terminal portion of the ileum, the caecum, and the right half of the transverse colon. The advantage of this limited operation is that it may be performed in one stage with safety. The antiperistaltic anastomosis renders the closure of the gap between the large and small intestine considerably easier than when an isoperistaltic union is made. So far as my limited experience goes, the results of this operation have been very satisfactory, and if time confirms this view it would seem to be preferable to a simple ileo-colostomy.

The technique of the operation is as follows:

The abdomen is opened in the middle line. The ileum is crushed and ligatured two inches from its termination. A pair of forceps is placed on the ileum distal to the ligature, and then the intestine is divided by the cautery between the ligature and the forceps, the division being extended into the mesentery for half an inch. I prefer to leave the invagination of the proximal end of the ileum until after the anastomosis of the colon has been effected, as by doing so one is able to regulate the amount invaginated so as to leave no part of the blind end projecting beyond the limit of the anastomosis.

The proximal end of the ileum is now anastomosed to the transverse just to the left of the middle line, the anastomosis being antiperistaltic. The ligatured end of the ileum is now invaginated by means of a serous suture so as to leave the blind extremity almost flush with the end of the anastomotic opening. Two pairs of crushing forceps are placed on the transverse colon in the line of the pylorus, and the gut is divided between the forceps with the cautery. The distal end of the transverse colon is closed by a serous suture passed over the forceps, so that when the forceps are removed the simple act of pulling the two ends of the suture tight invaginates the mucous surfaces into the bowel. The right half of the transverse colon, the ascending colon, the caecum, and the terminal portion of the ileum are now removed after ligature of their blood vessels. The free edge of the ileal mesentery is sutured to the great omentum, so as to leave no aperture through which intestine may prolapse. The abdomen is closed without drainage.

I think that this modified operation deserves an extended trial in those cases of intestinal stasis in which surgical treatment is necessary. Examination of the large intestine after removal supports the view that the caecum is the "cesspool" of the alimentary tract. In one of my cases I found, on opening the caecum after the operation,

putrid faeces mixed with bismuth which had been taken thirteen days before the operation. My experience of this operation is at present limited to 6 cases. All the patients recovered, 5 of them have been relieved completely, and the remaining patient is much better, but the operation is too recent to regard it as a cure.

The following case illustrates the use of this operation, and I think you will agree with me that operation was not entered on "lightly, inadvisedly, or wantonly." I have not performed an ileo-colostomy or colectomy on any patient without having had them under observation for five or six months, and in the great majority I have tried first the effect of removal of the appendix or the division of bands.

The patient was a young woman aged 22 years, who some years ago came under the care of my colleague, Dr. Soltau Fenwick. She had suffered from indigestion for many years. Four years before admission she began to suffer from pain after food, lasting until she vomited. This pain came on in attacks, some of which lasted for several months, although in between the attacks she suffered from flatulence and a heavy feeling after food. During the attacks the pain used to wake her up at night. At times the pain was so severe that she was doubled up with it. She had been in hospital previously for two months and was treated by gastric lavage.

At the time of her admission, under Dr. Fenwick, vomiting was almost constant. She could keep nothing down except soda and milk, and even this gave her pain. Constipation was very marked. Drugs appeared to have no effect. If charcoal was administered it was still unpassed at the end of a week. She was treated by gastric lavage and fed per rectum. After four weeks' treatment she improved, but two weeks after her discharge she was readmitted on account of the vomiting, although the pain was better. As she was no better after four weeks' further treatment, Dr. Fenwick asked me to open the abdomen with a view to removing the appendix. At the operation the appendix was found to contain three oval concretions and the mucosa was ulcerated. No abnormality was found in the stomach or gall bladder, but the caecum was large and mobile. After the operation she was better for a few weeks, but after she left hospital, although the pain almost disappeared, she continued to suffer from vomiting and extreme constipation. She was treated at home for several months with gastric lavage and liquid paraffin, but the vomiting continued. Six months after her discharge she was admitted once more into the hospital. Again she was fed rectally, but she could keep no food in her stomach except peptonized milk. Any other kind of food produced vomiting immediately, and even when on peptonized milk she had vomiting occasionally. After three months' medical treatment she was no better, and as she was steadily losing weight we agreed that the only course left was to short-circuit the colon. Accordingly I performed partial colectomy in the manner described. The patient made a good recovery and has remained quite well. Now, for the first time for ten years, she can eat all kinds of food and she has had no more vomiting. She says that her friends regard her as "resurrected."

The lot of those who suffer from the effects of intestinal stasis is so unenviable that it is our bounden duty seriously to consider all forms of surgical treatment, so that we may come to a decision as to the best procedure to be adopted in order to restore to the victims of this disorder their bodily and mental vigour and so enable them to resume their usual vocations and to enjoy the pleasures of life.

A CASE OF RETROPERITONEAL FIBROMA, WEIGHING 34¾ POUNDS, SUCCESSFULLY REMOVED.

By CHARLES P. CHILDE, F.R.C.S.,
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THE following case (with specimen produced) appears to be of sufficient interest to bring before the Section. G. T., schoolmaster, aged 48, consulted me on March 28th, 1912.

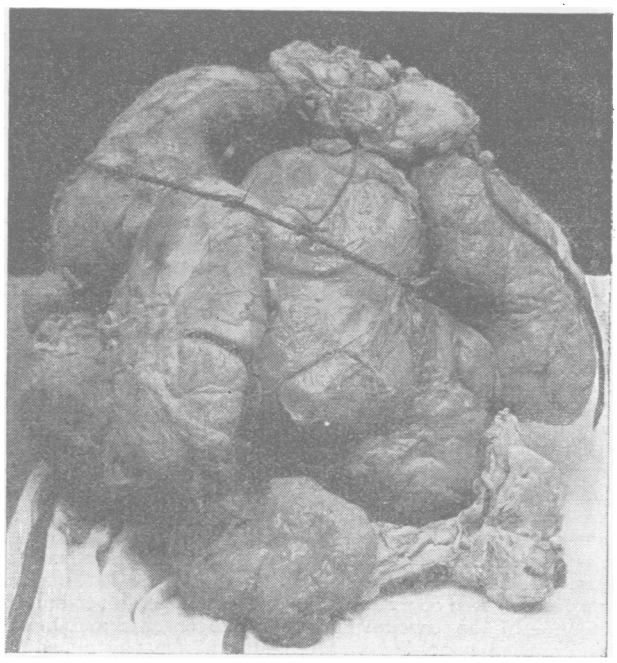
History.—Family history unimportant. No previous illness of any severity. Had suffered at times from constipation and "bilious attacks."

Present Illness.—Began about five years before with gradual enlargement of the abdomen. The swelling increased rapidly during the last year. During this time the constipation and "bilious attacks" from which he had previously suffered ceased. The only pain complained of was a sense of great discomfort owing to the size of the abdomen. No bladder trouble. Though he became considerably thinner during the last year, his weight increased from 11 st. 3 lb. to 12 st. 3 lb.

Condition Present.—The patient was very thin and rather sallow. An enormous tumour occupied the abdominal and pelvic cavities, completely filling them, and extended into both loins. Owing to its entire occupancy of the cavity it was impossible to move it at all, or to obtain any information as to its site of origin. On palpation it was firm and solid, with some bosses of stony hardness. (These turned out to be masses of ossification.) The measurement at the umbilicus was 41½ in., above the umbilicus 41¾ in., and below it 41 in. The heart, lungs, and kidneys were sound, and the tongue was clean.

Diagnosis.—On the first examination the fixity and stony hardness, combined with the rapidity of increase latterly, gave the impression of malignancy supervening on an innocent growth; but the total length of duration, combined with the fact that, though very thin, the man did not appear to be in an advanced stage of malignancy, pointed against it. His increase in weight was no doubt due to the growth of the tumour, for the rest of his body was very wasted. I induced him to allow me to make an exploratory incision.

Operation.—On March 31st, 1912, a median incision was made. The intestines were found packed away beneath the diaphragm, and the tumour was ascertained to be retroperitoneal. The posterior layer of peritoneum was divided and the most superficial lobule was shelled out. It was seen to contain some lobules of fat, and felt to contain some bone or calcareous matter. The incision was therefore prolonged from the ensiform cartilage to the pubes, and enucleation was proceeded with. Very large veins coursed over the surface of the tumour. Owing to the manner in which the tumour had insinuated itself everywhere—into the pelvis, far back into the loins, and



upwards beneath the diaphragm, making it almost impossible to insert a finger between the growth and its surroundings, the enucleation was exceedingly difficult. Besides, while working in the dark at the back of the tumour, great gentleness had to be exercised to avoid tearing one of the large veins, iliacs or vena cava, which would have been an awkward accident. When the tumour was partly got out it took two assistants to hold it and shift it from side to side while the deeper lobules were extricated from their bed. The operation occupied three hours. The tumour was eventually found to grow from the capsule of the left kidney, which had to be stripped off with it. The abdominal organs, after removal of the tumour, appeared healthy, and the abdomen was closed. Very little shock followed the operation, and an uneventful recovery ensued. The post-operative temperature did not rise beyond the normal. He has remained quite well.

Clinical Research Report.—The tumour is a fibroma, with considerable myxomatous areas. There are areas of ossification in it, or, more probably, in its capsule, and some adipose tissue is present, which we conclude is perirenal in origin. No cartilage, muscle, or other type of tissue is present, and there is no evidence of malignancy.

Remarks.—The chief interest lies in the enormous size of the tumour. One would hardly conceive it possible that a tumour of this size and density could cram itself into the retroperitoneal space, and that, too, without causing any pressure symptoms. In fact, "bilious attacks" and constipation, formerly present, disappeared with the growth of the tumour. The intestines were very empty. I imagine they had to keep themselves so. There was no room for accumulations of faeces and gas. A fortuitous circumstance was that the tumour, from its extreme hardness and absolute fixity, was not considered inoperable without an exploratory laparotomy.